Computer Science Department
Report No. STAN-CS-80-780

January 1980

12

THE COMPUTER MODERN FAMILY OF TYPEFACES

by

Donald E. Knuth

Research sponsored by

National Science Foundation
Office of Naval Research
IBM Corporation
Xerox Corporation

COMPUTER SCIENCE DEPARTMENT
Stanford University

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS
BEFORE COMPLETING FORM

1. REPORT NUMBER
STAN-CS-80-780

2. GOVT ACCESSION NO.
AD-A086359

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle)
The Computer Modern Family of Typefaces

5. TYPE OF REPORT & PERIOD COVERED
technical, January 1980

6. PERFORMING ORG. REPORT NUMBER
STAN-CS-80-780

7. AUTHOR(s)
Donald E. Knuth

8. CONTRACT OR GRANT NUMBER(s)
N00014-76-C-0330

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Department of Computer Science
Stanford University
Stanford, California 94305 USA

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS
Office of Naval Research
Department of the Navy
Arlington, Virginia 22217

12. REPORT DATE
January 1980

13. NO. OF PAGES
406

14. MONITORING AGENCY NAME & ADDRESS (if diff. from Controlling Office)
ONR Representative - Philip Surra
Durand Aeromautics Building, Room 165
Stanford University

15. SECURITY CLASS. (of this report)
Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

(see other side)

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

19. KEY WORDS (Continued)

20 ABSTRACT (Continued)

This report gives machine-independent definitions of all the styles of type planned for use in future editions of The Art of Computer Programming. Its main purpose is to provide a detailed example of a complete family of font definitions using METAFONT, so that people who want new symbols for their own books and papers will understand how to incorporate them easily. The fonts are intended to have the same spirit as those used in earlier editions of The Art of Computer Programming, but each character has been redesigned and defined in the METAFONT idiom. It is hoped that some readers will be inspired to make similar definitions of other important families of fonts. The bulk of this report consists of about 400 short METAFONT programs for the various symbols needed, and as such it is pretty boring, but there are some nice illustrations.

Computer Science Department
Report No. STAN-CS-80-780

14

11 January 1980
(first printing)

12 207

6

THE COMPUTER MODERN FAMILY OF TYPEFACES

10 Donald E. Knuth

9 Technical rept.

15 N00014-76-C-0330

094 120

The preparation of this report was supported in part by the National Science Foundation, the Office of Naval Research, and the IBM Corporation. The author also wishes to thank the Xerox Corporation for providing facilities with which this report was printed, and for providing computer time while the Stanford computers were being moved to a new building.

PREFACE

This report gives machine-independent definitions of all the styles of type planned for use in future editions of *The Art of Computer Programming*. Its main purpose is to provide a detailed example of a complete family of font definitions using METAFONT, so that people who want new symbols for their own books and papers will understand how to incorporate them easily. The fonts are intended to have the same spirit as those used in earlier editions of *The Art of Computer Programming*, but each character has been redesigned and defined in the METAFONT idiom. It is hoped that some readers will be inspired to make similar defintions of other important families of fonts. The bulk of this report consists of about 400 short METAFONT programs for the various symbols needed, and as such it is pretty boring, but there are some nice illustrations.

It seems appropriate to give the name "Computer Modern" to this family of fonts, because of their associations with computers and because of the fact that the analogous Monotype fonts are called "Modern 8A". Monotype Modern 8A served for many years as a *de facto* standard for high quality typesetting of mathematics, since these fonts had the most complete collection of characters and special symbols in all the necessary sizes. But the typesetting of technical material has low priority in the printing industry; so the Modern fonts had still not been adapted to photo-optical or photo-digital typesetting equipment by 1977, when Volume 2 of *The Art of Computer Programming* (second edition) was due to appear. Meanwhile the hot-lead Monotype equipment was rapidly becoming extinct and prohibitively expensive, so there was no good way to print the second edition in the style of the first.

A preliminary version of Computer Modern was designed by the author in the fall of 1977 and the spring of 1978, using a prototype version of METAFONT. This prototype system included subroutines for drawing curves with pens and erasers, but it did not have METAFONT's declarative language; all characters were drawn by means of subroutine calls written in SAIL code. During this time Robert Filman suggested that it would be much better to have a language that could be interpreted, so that simple changes to a font definition would not require recompiling a large program. During the summer of 1978, the author therefore used the experience gained while defining all the characters in proto-METAFONT to design a new language embodying the operations that had turned out to be necessary and desirable. METAFONT itself was programmed during the first part of 1979, and all of the Computer Modern character definitions were revised and rewritten in the new language during late 1979. The resulting programs appear in this report.

The design of Computer Modern is nearly complete, but some improvements will doubtless be made. In fact, one of the goals of this report is to circulate the preliminary definitions in order to obtain critical comments before it is too late to make changes easily. The need to spread this information quickly explains the somewhat paradoxical fact that 1978 Computer Modern fonts have been used to typeset this report, even though it describes the 1979 Computer Modern characters. With luck, the 1978 version of Computer Modern fonts will disappear from the faces of the earth by the spring of 1980, when they will be replaced by the final form of the designs appearing here. The author hopes to produce a properly typeset book describing METAFONT and Computer Modern when a "steady state" is achieved.

Since the publication of the METAFONT manual, the language has changed in one respect (incorporated into the programs here): The height of lpens and rpens is now specified independently by lpenht and rpenht statements. Formerly the hpenht statement was used for all three heights, but this turned out to be an unnecessary restriction.

Appendix E of the METAFONT manual was written when only two of the Computer Modern letters had been defined—namely, the "A" and the "B" used as examples in that appendix. The introduction to the present report is essentially a revised version of Appendix E, incorporating several dozen improvements and correcting some embarrassing errors.

—D.E.K., January 1980

CONTENTS

INTRODUCTION

A complete font design is a complex system, so there are several levels at which one might understand it and use it—depending on how much of the "black box" is being opened. At the outermost level, all of the details can be left alon and we simply generate a particular font. For example, there is a file called "cmr10.mf", and when METAFONT is applied to that file it will produce the "Computer Modern Roman 10 point" font. Another file "cmsss8.mf" produces "Computer Modern Slanted Sans Serif 8 point," and so on. But if we actually look into files like cmr10.mf and cmsss8.mf, we find that they are quite short; they merely set up the values of certain parameters and input the file "roman.mf", which specifies the actual METAFONT programs for individual letters. Therefore it is easy to make up a customized font for a particular application, simply by setting up new values of the parameters and inputting roman.mf ourselves.

At a still deeper level, we can also look at the file roman.mf, which provides 128 short programs for the individual character shapes (followed by ligature and kerning definitions). These short programs are fairly independent, and they aren't completely inscrutable; it isn't difficult to substitute a new routine or two for characters that we wish to modify, since the programs make use of some fairly flexible subroutines that appear in file cmbase.mf.

At the deepest level, we could also fiddle with the subroutine definitions in cmbase.mf—and of course that would essentially amount to the creation of a new family of fonts.

In this report we shall study the Computer Modern fonts by working our way in from the outermost level, then going back out again. File cmr10.mf looks like this:

"Computer Modern Roman 10 point";
$ph = \frac{250}{36}$; $px = \frac{160}{36}$; $pe = \frac{90}{36}$; $pd = \frac{70}{36}$;
$pb = \frac{20}{36}$; $po = \frac{4}{36}$; $ps = \frac{20}{36}$; $pa = .5(ph - pd)$;
$pw = \frac{9}{36}$; $pwi = \frac{27}{36}$; $pwii = \frac{12}{36}$; $pwiii = \frac{30}{36}$;
$pwiv = \frac{32}{36}$; $pwv = \frac{38}{36}$; $aspect = 1.0$;
$pu = \frac{20}{36}$; $lcs = 1.075$; $ucs = 1.7$; $sc = 0$; $ls = 0$;
$slant = 0$, $sqrttwo = \mathrm{sqrt}\,2$; $fixwidth = 0$;
$halfd = 0$; $varg = 0$, $lowast = 0$, $ligs = 1$.
input cmbase;   call *fontbegin*;
input roman;
end.

In other words, the file sets up a lot of parameters and then it does "input roman" to create the font.

We can obtain a great variety of related fonts by setting these parameters in different ways, once we know what they mean; and here's what they mean:

By convention, all of the parameters whose name begins with "*p*" are in units of printers' points. First come eight parameters covering important vertical dimensions:

ph is the h-height, the distance from the baseline to the top of an "h".

px is the x-height, the distance from the baseline to the top of an "x"

pe is the e-height, the distance from the baseline to the bar of an "e"

pd is the descender depth, the distance from the baseline to the bottom of a "p".

pb is the border height; characters extend as much as $ph + pb$ above the baseline and $pd + pb$ below it

po is the amount of overshoot for optical adjustments at sharp corners, e g , "A" is this much taller than "B".

ps is the vertical distance at which serif bracketing is tangent to the stems.

pa is the axis height, the distance from the baseline to the point where mathematical symbols like "+" and "-" have vertical symmetry.

Then there are seven parameters affecting the pen sizes.

pw is the hairline width, used in the thinnest parts of letters

pwi is the stem width, used for the vertical strokes in an "h"

pwii is the curve width, used in an "o" at its widest point.

pwiii is the dot width, the diameter of the dot on an "i"

pwiv is the upper-case stem width, used for the vertical strokes in an "H".

pwv is the upper-case curve width, used in an "O" at its widest point.

aspect is the ratio of a hairline pen's height to its width.

Next come five parameters concerning horizontal dimensions:

pu is the unit width, 1/18 of an em.

lcs is the amount by which serifs of lower-case letters project from the stems, in units of *pu*.

ucs is the amount by which serifs of upper-case letters project from the stems, in units of *pu*.

sc is the serif correction in units of *pu*; each letter specifies multiples of *sc* by which its width is to be decreased at the left and the right.

ls is the amount of letter spacing in units of *pu*; each letter is made this many units wider than the design actually specifies.

Finally we have miscellaneous parameters that control special effects:

slant is the amount of additional increase in x per unit increase in y, used to slant letters either *forwards* or backwards.

sqrttwo is used to control the ellipticity of the bowls of letters, as explained in Chapter8 of the METAFONT manual.

halfd is nonzero if certain characters like "," are to descend only half as far as lower-case letters do.

varg is nonzero if the simple "g" shape is to replace the classical "g".

lowast is nonzero if the asterisk is to be lowered so that it is centered on the axis.

ligs is nonzero if the roman font is to have the character set that TEX expects for text fonts with ligatures. (Otherwise eighteen special symbols are substituted for the ligature-oriented characters.)

File cms10.mf ("Computer Modern Slanted 10 point") is exactly the same as file cmr10.mf, except for its title and the fact that *slant* = 0 15. Similarly, the settings of parameters in file cmb10.mf ("Computer Modern Bold 10 point") are nearly identical to those of cmr10.mf, except that the pens are bigger:

$$pw = \tfrac{13}{36};\quad pwi = \tfrac{10}{36};\quad pwii = \tfrac{15}{36};\quad pwiii = \tfrac{50}{36};$$
$$pwiv = \tfrac{50}{36};\quad pwv = \tfrac{50}{36};$$

furthermore serifs are shorter (*lcs* = .85, *ucs* = 1 5).

File cmr5 mf generates 5-point type, but it is not simply obtained by halving the parameters of cmr10. The eight vertical dimensions *ph*, *px*, ..., *pa* are exactly half as large as before, but the pen sizes and the horizontal dimensions get smaller at different rates [illegible]. The following settings are used:

$$pw = \tfrac{7}{36},\quad pwi = \tfrac{17}{36},\quad pwii = \tfrac{10}{36};$$
$$pwiii = \tfrac{20}{36},\quad pwiv = \tfrac{10}{36},\quad pwv = \tfrac{20}{36};$$
$$pu = \tfrac{12.5}{36},\quad lcs = 0.84,\quad ucs = 1.32.$$

Two more examples should suffice to illustrate the variation of these parameters. The bold sans-serif font used in this sentence is called "Computer Modern Sans Serif 10 point Bold Extended" (cmssb). It uses the same vertical dimensions and miscellaneous

settings as cmr10, and gets its other characteristics from the following parameter values:

$$pw = pwi = pwii = pwiii = \tfrac{31}{36};$$
$$pwiv = pwv = \tfrac{12}{36},\quad aspect = \tfrac{23}{37};$$
$$pu = \tfrac{22}{36},\quad lcs = ucs = 0;\quad sc = \tfrac{9}{22};\quad ls = 0.$$

To get the typewriter font "cmtt" used in this sentence, set

$$ph = \tfrac{210}{36},\quad px = \tfrac{150}{36},\quad pe = \tfrac{75}{36};\quad pd = \tfrac{80}{36};$$
$$pb = \tfrac{30}{36};\quad po = \tfrac{1}{36},\quad ps = 0,\quad pa = 5ph;$$
$$pw = pwi = pwii = pwiv = pwv = \tfrac{20}{36},$$
$$pwiii = \tfrac{10}{36},\quad aspect = 1\,0,$$
$$pu = \tfrac{24}{36},\quad lcs = \tfrac{11}{21},\quad ucs = \tfrac{15}{21},\quad sc = 0;\quad ls = 0,$$
$$slant = 0,\quad sqrttwo = \text{sqrt}\,2,\quad fixwidth = 1,$$
$$halfd = 1;\quad varg = 0\quad lowast = 1;\quad ligs = 0$$

By making stranger settings of the parameters you can also get stranger fonts like this. The font definitions are not able to produce satisfactory results for all possible combinations of parameter settings, but they do try to handle all "reasonable" variations

The programs for Computer Modern can be used in several ways. The general procedure is to run METAFONT and type

```
mode = ⟨mode number⟩. input ⟨font name⟩;
```

the routines will act differently depending on the specified mode. At present mode 0 generates proof sheets and shows the letters as they are being drawn, with a resolution of 36 pixels per point; mode 1 generates a font for the XGP or Versatec or Varian, etc., with a resolution of 3 6 pixels per point, mode 2 generates a font for the CRS with a resolution of 73 7973 pixels per point, displaying the titles of the letters as they are being drawn, mode 3 is like mode 1 but for a Dover, and other modes cause a file mode mf to be read in, where this file specifies METAFONT's mode of operation. In mode 0 the letters appear on a background grid as shown in the illustrations of this report, so that you can see the settings of the parameters in a convenient way. If you wish to see the characters as they are being drawn, you can type "chardisplay, *mode* = 1 input ⟨font name⟩", etc

All of the illustrations of individual characters in this report were generated with mode 0, except for the characters of the math extension font these were done in a similar way but only half size (with 18 pixels per point), because so many of the characters of this font are quite large

Actually mode 0 is rarely used with an entire font like cmr10, it is generally used only to test out new characters. In that case you can make up a file called "test mf" containing the characters you wish to try, and simply input the system file "proof mf", which has the following form:

```
mode = 0;   input cmbase;
ph = 250/36   ...(set up for cmr10) ..;   call fontbegin.
input test;
```

```
new pw, ...(set up for cmb10)...;   call fontbegin.
input test;
new pw, ...(set up for cmssb)...;   call fontbegin.
input test;
new ph, ...(set up for cmtt)...;   call fontbegin.
input test;
new ph, ...(set up for cmssa8)...;   call fontbegin.
input test;
end.
```

Thus, it runs your test file against five different settings of the parameters.

The programs for individual characters in this report fall into four main groups: First comes the roman group, which makes text fonts either with ligatures (like cmr10) or without (like cmtt). Then comes the italic group, which is somewhat similar, but it either makes text fonts with ligatures (like cmti10) or italic fonts for mathematical formulas (like cmi10). The third group is called symbol, and it makes math symbols (like cmsy10). Finally there is the mathex group, for extended math symbol fonts (like cmathx).

Let's go one level deeper and take a look at the programs for individual letters. Such programs are expressed in terms of variables something like the parameters we have been discussing, but the variables are slightly different since the letters are to be drawn on a raster and we need to work in raster units instead of printers' points. The point-oriented variables *ph*, *px*, *pe*, etc., have corresponding raster-oriented variables, satisfying the approximate relation

$$(\text{raster-oriented variable}) \approx \mathit{pixels}\cdot(\text{point-oriented variable}),$$

where *pixels* is the number of pixels per point. This relation is only approximate, not exact, because the raster-oriented variables have been rounded to values that help to provide satisfactory discretization of the characters. As explained in Chapter 7 of the manual, good designs are written with discreteness in mind, although METAFONT tries to do the right thing automatically when it can.

There are seven raster-oriented variables corresponding to seven of the eight pixel-oriented vertical dimensions, namely

$$h \leftrightarrow ph,\ m \leftrightarrow px,\ e \leftrightarrow pe,\ d \leftrightarrow pd,\ b \leftrightarrow pb.\ o \leftrightarrow po,\ a \leftrightarrow pa;$$

in other words, we just drop the "*p*", except in the case of "*px*" (since a variable can't be named "*x*"). Variable *m* is used to stand for the x-height, since a line at this height is traditionally called the "mean line" The baseline of each character is row 0, so the bottom pixel of a letter like "h" has *y*-coordinate 0. The top pixel of an "h" is in row *h*, which is always an integer. (Note that there are actually $h+1$ occupied rows, not *h*, although *h* is called the h-height.) The top pixel of an "m" is in row *m*, and the bottom pixels of the descender letters (g,j,p,q,y) appear in row $-d$. All three of these variables (h, m, d) are integers, and so is the overshoot variable *o* (which is used as a correction to *h*, *m*, or *d* in certain cases). Variable *e* is either an integer or an integer plus $\frac{1}{2}$, whichever is better for a pen of the hpen height, since the bar of an "e" is drawn with an hpen and its *y*-coordinate is *e*. Variable *b* is an integer calculated in such a way that tall characters can run up to row $h+b$ and deep characters can descend to row $-d-b$; more precisely, it is the smallest

integer such that $h+d+2b+1$ rows of the raster occupy a vertical distance that exceeds or equals the true point size $ph+pd+2pb$.

The pen sizes in Computer Modern programs for individual letters are generally expressed in terms of the following variables, each of which has a positive integer value intended to approximate the "true" infinite-resolution value (and slightly increased in order to look right on the output device, depending on the current mode):

w_0, the hairline width;
w_1, the stem width;
w_2, the curve width;
w_3, the dot diameter;
w_4, the upper-case stem width;
w_5, *the upper-case curve width;*
w_6, the hairline height;
w_7, the stem height;
w_8, the curve height;
w_9, the upper-case stem height,
w_{10}, the rule thickness for math symbols.

Note that the last five of these variables have no "*p*-variable" equivalent, they satisfy the approximate relations

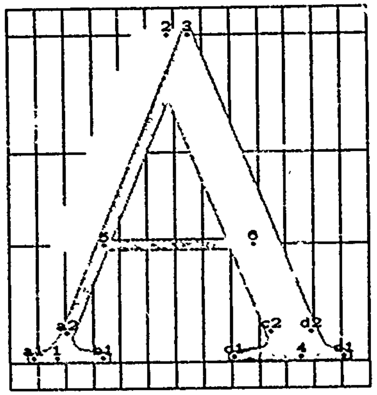
$$w_6/w_0 \approx w_7/w_1 \approx w_8/w_2 \approx w_9/w_4 \approx \mathit{aspect}, \quad w_{10} \approx 25[w_0, w_2].$$

The hpenht, lpenht, and rpenht are w_6, and the vpenwd is w_0. Thus, an hpen of size w_0 is equivalent to a vpen of size w_6; we may call it the "hairline pen" for the font

In the horizontal dimension, the Computer Modern programs make frequent use of variable *u*, the approximate unit width when there are 18 units to an em. The width of a character is expressed in terms of units (e.g., an "h" is 10*u* wide, unless there is a serif correction $sc \neq 0$ or some additional letter spacing $l \neq 0$), and key positions can be specified as a certain number of units from the left (e.g., the stems of an "h" are centered at 2.5*u* and 7.5*u*). The vertical guidelines in the illustrations of this report are one unit apart.

If the character is *t* units wide, variable *u* has been calculated so that *t* times *u* is an integer *r*, the rightmost column of the character. (The value of *u* itself is usually not an integer, nor need *t* be an integer.) Just as a character typically occupies rows 0 through *h*, inclusive, in the vertical direction, we use columns 0 through *r* inclusive in the horizontal direction, although most characters leave white space at the left and right boundaries. The integer *r* is calculated so that, in the absence of corrections due to serifs or letter spacing, etc., $r+2$ is the nearest integer to the character's true width (*t* *pu* *pixels*), the reason for this extra "$+2$" is that low-resolution devices should keep a blank column (column $r+1$) between adjacent characters. However, it is best for conceptual purposes to think of *r* as the character's actual width, and to think of "$r-2.5u$" as a point $2\frac{1}{2}$ units from the right edge, etc.

Variable oo is an integer approximation to one-half of *o*, it is used for "half of an overshoot," when curved lines approach the bottom or the top of a character. Variable *dd* is like *d* except it is only half as large, when *halfd* is nonzero. A few other variables like this are defined for use in several different characters, either in file cmbase or at the beginning of a file containing character definitions, but the variables described above are by far the most important.



Upper-case "A" defined by the example program.

We're ready now to look more closely at a program for the upper-case letter "A" (see the boxed example on page 13). The first line of that program simply gives the title that will appear on proof sheets, or possibly on the terminal when the character is being drawn. Then comes a call to the *charbegin* subroutine, with seven parameters: the character code, the width of the character in units, the respective amounts in units that are to be trimmed from the left and from the right, and finally the character's height, depth, and italic correction. These last three parameters must be in absolute units of printers' points, hence *ph* (not *h*) must be used for the height.

The next few lines give eight equations to define the locations of points 1, 2, 3, and 4. First point 1 is positioned so that, using an hpen of size w_0 (the hairline pen), the pen's left edge will be 1.5 units from the left edge of the character, and the bottom will be on the baseline. Similarly point 4 is placed so that the pen's right edge will be 1.5 units from the right edge of the character and the bottom will be on the baseline, where this time the pen is an hpen of size w_5. (The upper-case curve width w_5 is used here in preference to the stem width w_1, since a diagonal stroke tends to decrease the effective pen width.) The positioning of points 2 and 3 is more interesting: the idea is that we want to draw a line from 2 to 4 with an hpen of width w_5, and another from 3 to 1 with an hpen of width w_0. First we define y_2 and y_3 so that the top occurs at the h-height h, plus the "overshoot" o that gives this letter a touch of class. Then we state that $x_3 - x_1 = x_1 - x_2$, so that the two diagonal strokes will have the same slopes (the same amount of change in the x direction). Finally we stipulate that $\mathrm{rt}_5x_2 = \mathrm{rt}_0x_3$, so that the line from 2 to 4 will have the same top right boundary as the line from 1 to 3. These equations give METAFONT enough information to determine points 2 and 3 uniquely.

After drawing the right diagonal stroke, we need to erase part of the stem line at the top, where it protrudes to the left of the left stroke (which is thinner). Before erasing anything, however, we may as well draw the bar line. Computer Modern fonts place this line at the e-height, the same level as the bar line in an "e", hence $y_5 = y_6 = e$. The calculation of x_5 and x_6 is slightly trickier; x_5 lies between x_1 and x_3, and the ratio of its distance is the same as the ratio for y_5 with respect to y_1 and y_3. The equations "$x_5 = aa[x_1, x_3]$, $y_5 = aa[y_1, y_3]$" would almost surely work to define a suitable point, but the program actually uses $x_5 - 1$ instead of x_5, just to be absolutely safe against weird possibilities of rounding that might cause the bar line to stick out at the left. (It doesn't hurt to start a line one pixel to the right of a point that lies on another line.)

```
"The letter A";
call charbegin(`A, 13, 2sc, 2sc, ph, 0, 0);
hpen;
lft0x1 = round 1.5u;   bot0y1 = 0;
rt5x1 = round(r − 1.5u),   bot5y1 = 0:
top0y3 = top5y2 = h + o;
x3 − x1 = x1 − x2,   rt5x2 = rt0x3,
w5 draw 2..4;                                    % right diagonal stroke
y5 = y6 = e;
new aa, bb;              % auxiliary variables for intersection of lines
x5 − 1 = aa[x1, x3];   y5 = aa[y1, y3],
x6 + 1 = bb[x1, x2];   y6 = bb[y1, y2].
w0 draw 5..6,                                              % bar line
lpen#;   w5 draw 3..5;                     % erase excess at upper left
hpen;   w0 draw 3..1;                              % left diagonal stroke
if ucs ≠ 0:
     call `a serif(1, 0, 3, −.5ucs),
     call `b serif(1, 0, 3, +ucs);                         % left serifs
     call `c serif(4, 5, 2, −ucs);
     call `d serif(4, 5, 2, +.5ucs);                       % right serifs
fi
```

A METAFONT program for upper-case "A"

Now the lpen# is used to erase unwanted black pixels, changing them back to white. Actually this erases more than we wanted to get rid of, since it has a rectangular shape and we are erasing at an angle, but that doesn't matter, because the left diagonal stroke blackens all the necessary pixels. (Note that the eraser also does away with part of the guidelines in the proof drawing of the figure.)

Finally the *serif* subroutine is used to attach fancy serifs at points 1 and 4; these serifs extend .5*ucs* units outwards and *ucs* units inwards. Details of this subroutine appear below.

Once you understand this program for "A", you will have no trouble writing programs for "V" and "v", as well as for the Greek letter "Λ", and you will be well on your way to having "M" and "W". Similarly, the code below for "B" leads to "D" and "P" with little further ado.

We shall now plunge into the deepest level, the subroutines in cmbase.mf that take care of nasty details. These subroutines are presented on the following pages for reference purposes; it's probably best not to read them until you have to.

The file cmbase.mf

```
eps = 000314159;                                   % a very small random positive number
if mode = 0:   proofmode;   drawdisplay;   titletrace,
     pixels = 18;   blacker = 0;
else:   if mode = 1:   fntmode;   tfxmode;   no modtrace;
          pixels = 3.6;   blacker = 1.2;                      % XGP, Versatec, Varian, etc.
     else:   if mode = 2:   crsmode;   tfxmode;   titletrace;   no modtrace;
               pixels = 73.7973;   blacker = 1;                           % Alphatype
          else:   if mode = 3:   fntmode;   tfxmode;   no modtrace;
                    pixels = 3.6 * (1.1/1.3) * (381/200);   blacker = 1.2;          % Dover
               else:   input mode;
               fi;
          fi;
     fi;
fi.


subroutine fontbegin:                               % Initialize before making a font:
no eqtrace;                                 % Turn off tracing within this subroutine
new typesize;                                       % the vertical size of the font
new cf;                            % conversion factor, approximately equal to pixels
new h, d, dd, m, e, o, oo, b, s, a;                 % raster-oriented vertical dimensions
new w0, w1, w2, w3, w4, w5, w6, w7, w8, w9, w10, w11;          % raster-oriented pen sizes
new deltaw, bold;                          % unrounded raster-oriented pen size values
new armic, lcic;                                    % italic corrections commonly used
new lcss;                                                  % lower case short serif
new prt;                                                 % rule thickness in points
w0 = round(pixels·pw + blacker);                                  % hairline width
w1 = round(pixels·pwi + blacker);                                     % stem width
w2 = round(pixels·pwii + blacker);                                   % curve width
w3 = round(pixels·pwiii + blacker);                                 % dot diameter
w4 = round(pixels·pwiv + blacker);                          % uppercase stem width
w5 = round(pixels·pwv + blacker);                          % uppercase curve width
w6 = round(pixels·pw·aspect + blacker);                          % hairline height
w7 = round(pixels·pwi·aspect + blacker);                             % stem height
w8 = round(pixels·pwii·aspect + blacker);                           % curve height
w9 = round(pixels·pwiv·aspect + blacker);                 % uppercase stem height
prt = .25[pw, pwii];                                     % rule thickness in points
w10 = round(pixels·prt + blacker);                % raster-oriented rule thickness
w11 = round(pixels(.2[pw, pwi])·aspect + blacker);         % hairline plus a little
deltaw = pixels·(pwii − pwi);                             % one step of boldening
bold = .5[pwii, pwiii]·pixels + blacker;
```

```
% The following corrections are for low resolution:
if w3/w1 > (3/2)(pwiii/pwi):   new w2, w1,   w2 = w3 = w1;
fi;
if w5/w1 > (3/2)(pwv/pwiv):   new w5;   w5 = w1;
fi;
if w8/w7 > (3/2)(pwii/pwi):   new w8;   w8 = w7;
fi;
hpenht w6;   vpenwd w0,   lpenht w6;   rpenht w6;
typesize = ph + pd + 2pb;   cf·typesize = pixels·typesize − 1;
h = round cf·ph;   d = round cf·pd,
new pdd;   pdd = (1 − .5halfd)pd;   dd = round cf·pdd;
m = round cf·px;
o = round cf po;   oo = round .5cf po;   s = cf·ps,
a =  5 round 2cf·pa,
b = -  round( 5(h + d − typesize·pixels));
hpen;   e = good0 cf·pe;
maxht h + b + 2;
trxy slant;
if ucs ≠ 0:   armic = ph slant + (sc − 1)pu,
else:   armic = ph slant + (sc − 5)pu,
fi;
if pwii > 1.5pu:   lcic = −.25pu;
else.   lcic = .5pwii − pu;
fi;
if pw ≐ pwi:   lcss = lcs;
else:   lcss = .5lcs;
fi.
```

```
subroutine charbegin(var charno)                          % seven-bit character code
          (var charuw)                                    % character width in units
     (var lftcorr, var rtcorr)                            % serif-oriented corrections in units
(var charh, var chard, var chari):              % charht, chardp, charic values in points
no eqtrace;  no calltrace;  no drawdisplay;               % no tracing in this subroutine
new uw, moduw;                                  % the correct character width in units
new r;                                                  % raster-oriented character width
new u;                                                      % raster-oriented design unit
new tu;                                                % unmodified raster-oriented unit
new italcorr;                                                         % italic correction
new lcorr, rcorr;                                            % left and right corrections
if chari ≥ 0:   italcorr = chari;   else:   italcorr = 0;
fi;
if danger ≠ 0:                                % rounding of character width is necessary
     lcorr = danger·round((lftcorr — ls)/danger);
     rcorr = danger·round((rtcorr — ls)/danger);
else:   lcorr = lftcorr — ls;   rcorr = rtcorr — ls;
fi;
tu = pu·pixels;   uw = charuw — (lcorr + rcorr);
if fixwidth = 0:   moduw = uw;
else:   moduw = 9;   new italcorr;   italcorr = 0;
fi;
r = charuw·u = round((moduw·tu — 2) charuw/uw);
charcode charno;   charic italcorr;
if charh > 0:   charht charh;
else:   charht 0;
fi;
if chard > 0:   chardp chard;
else:   chardp 0;
fi;
charwd moduw·pu;   chardw moduw·tu;
incx round(—lcorr·u);
if mode = 0:   call box(round lcorr u);
fi.
```

```
subroutine box(var offset):                      % Draw guidelines and box around a character:
no drawtrace;   no proofmode,
new topp, bott, left, right, pos;
topp = h + b;   bott = —d — b;
left = offset;   right = offset + u·uw;
x1 = x3 = x5 = x7 = x9 = x11 = x13 = x15 = x17 = left;
x2 = x4 = x6 = x8 = x10 = x12 = x14 = x16 = x18 = right;
y1 = y2 = 0;   cpen,   1 draw 1..2;                                      % baseline
y3 = y4 = e;   draw 3..4;                                                % e-height
y5 = y6 = m;   draw 5..6;                                   % mean line (x-height)
y7 = y8 = h;   draw 7..8;                                                % h-height
y9 = y10 = topp;   draw 9..10;                                   % top of character
y11 = y12 = —d;   draw 11..12;                                     % descender line
y13 = y14 = bott,   draw 13..14;                              % bottom of character
trxy 0;                                                % temporarily turn off the slant
y15 = y16 = topp;   y17 = y18 = bott,
draw 15..17,   draw 16..18;                                  % left and right edges
if italcorr > 0:   x19 = x20 = right + italcorr pixels,
     y19 = topp;   y20 = 0;   draw 19..20;                  % show italic correction
fi;
trxy slant;                                          % restore slanted transformation
pos = 0;   call unitlines.                                % draw the unit guidelines

subroutine unitlines:                         % Recursive subroutine to draw guidelines
x1 = x2 = pos;   y1 = topp;   y2 = bott;   cpen,
if pos ≥ left:   1 draw 1..2;
fi;
new pos,   pos = x1 + u;
if pos ≤ right:   call unitlines,
fi.
```

```
% The following subroutines are used to draw common features oi :haracters.
subroutine serif(index i)                                % point where seiif appears
          (index k)                                       % w-variable for stem line
          (index j)                                 % another point on the stem line
          (var sl):                                                % serif length
y_1 = y_i;
if y_i < y_j:   y_2 = y_i + s;
else:   y_2 = y_i - s;
fi;
hpen;
if sl < 0:   lft_0 x_1 = lft_k x_i + sl·u - eps;
      lft_0 x_2 = lft_k(y_2 - y_i)/(y_j - y_i)[x_i, x_j];
else:  rt_0 x_1 = rt_k x_i + sl·u + eps;
      rt_0 x_2 = rt_k(y_2 - y_i)/(y_j - y_i)[x_i, x_j];
fi;
no proofmode;
x_3 = 1/3[x_1 - sl·u, 1/2[x_1, x_2]];
y_3 = 1/3[y_i, 1/2[y_1, y_2]];
minvr 0;   minvs 0;
w_0 ddraw 1{x_i - x_1, 0}..3..2{x_j - x_i, y_j - y_i}, 1..1..i;
minvr 0.5;   minvs 0.5.

subroutine darc(index i)                                      % starting point
          (index j)                                   % opposite corner point
          (var maxwidth):                % the pen grows from w_0 to this size
x_5 = x_i;   x_2 = x_4 = 1/sqrttwo[x_i, x_j];   x_3 = x_j;
y_5 = y_j;   y_3 = 1/2[y_i, y_j];
y_2 = 1/sqrttwo[y_3, y_i];   y_1 = 1/sqrttwo[y_3, y_j];
hpen;   draw |w_0|i{x_3 - x_i, 0}..|2/3[w_0, maxwidth]|2{x_3 - x_i, y_3 - y_i}..
     |maxwidth#|3{0, y_3 - y_i}..
     |2/3[w_0, maxwidth]|4{x_5 - x_3, y_5 - y_3}..|w_0|5{x_5 - x_3, 0}.

subroutine arc(index i)                                  % horizontal endpoint
          (index j)                                      % vertical endpoint
          (var maxwidth):                % the pen grows from w_0 to this size
x_1 = 1/sqrttwo[x_i, x_j];   y_1 = 1/sqrttwo[y_j, y_i];
hpen;   draw |w_0|i{x_j - x_i, 0}..|2/3[w_0, maxwidth]|1{x_j - x_i  y_j - y_i}..
     |maxwidth|j{0, y_j - y_i}.
```

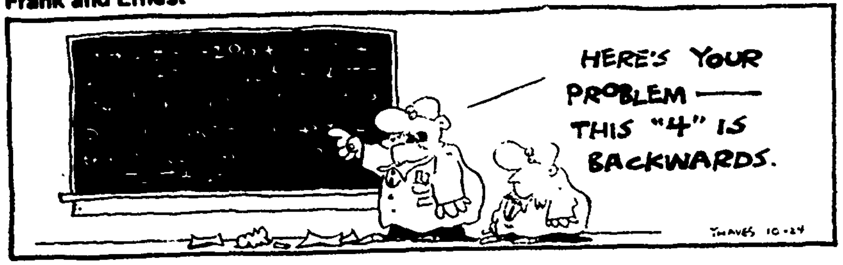
```
subroutine arm(index i)                                          %̣ starting point
          (index j)                                      % horizontal endpoint
          (index k):                                          % serif endpoint
hpen;
if ucs ≠ 0:
     if w_0 = w_1:   x_1 = x_2 = x_k;   y_1 = y_j;
          if y_k < y_j:   y_2 = y_j - aspect·ucs·u;
          else:   y_2 = y_j + aspect·ucs·u;
          fi;
          w_0 draw i..1;   draw 1..2;
     else:  minvr 0;   minvs 0;
          x_1 = x_j - (x_k - x_j);   y_1 = .3[y_j, y_k];
          x_2 = x_k;   y_2 = 2[y_j, y_k];
          w_0 ddraw i..j .k, i{x_j - x_i, 0}..1..k(..2);
          minvr 0.5;   minvs 0.5;
     fi;
else:   x_1 = x_k;   y_1 = y_j;   w_0 draw i..1;
fi.

subroutine scomp(index i)                                      % starting point
          (index p)                     % turning point (y_p to be defined)
          (index j)                        % transition point (to be defined)
          (index k)                                          % ending point
          (var slope):                                        % ending slope
% This subroutine computes y_p, x_j, y_j so that y_k - y_j = slope.(x_k - x_j)
% and so that the following curve is consistent with an ellipse:
% i{x_p - x_i, 0}..p{0, y_p - y_i}..j{x_k - x_p, slope.(x_k - x_p)}.
y_k - y_j = slope(x_k - x_j);
new aa, bb;   aa = slope(x_p - x_i);   bb = y_k - y_i - slope(x_k - x_i);
x_j - x_i = -2aa·bb(x_p - x_i)/(aa·aa + bb bb);
y_p - y_i = .5(bb·bb - aa·aa)/bb.
```

```
subroutine sdraw(index i)                                  % starting point
        (index p)             % upper turning point ($y_p$ to be defined)
        (index k)                                           % middle point
        (index q)             % lower turning point ($y_q$ to be defined)
        (index j)                                           % ending point
        (var penwd)                       % effective width of hpen used
        (var penht)                  % effective pen height at point $k$
        (var slope):                               % slope at point $k$
new $w_{18}, w_{19}$;   $w_{18} = penht$;   $w_{19} = penwd$;
cpen;   $top_8 y_5 = top_{18} y_k$;   $bot_6 y_6 = bot_{18} y_k$;   $x_5 = x_6 = x_k$;
if $x_p < x_i$:   $rt_{19} x_p = rt_0 x_1$;   $lft_{19} x_p = lft_0 x_2$;   $rt_{19} x_q = rt_0 x_9$;   $lft_{19} x_q = lft_0 x_{10}$;
else:   $lft_{19} x_p = lft_0 x_1$;   $rt_{19} x_p = rt_0 x_2$;   $lft_{19} x_q = lft_0 x_9$;   $rt_{19} x_q = rt_0 x_{10}$;
fi;
$y_2 = y_p$;   $y_9 = y_q$;
call scomp(i, 1, 3, 5, slope);                  % compute $y_1$ and point 3
call scomp(i, 2, 4, 6, slope);                  % compute $y_2$ and point 4
call scomp(j, 9, 7, 5, slope);                  % compute $y_9$ and point 7
call scomp(j, 10, 8, 6, slope);              % compute $y_{10}$ and point 8
hpen;   $w_0$ ddraw $i\{x_1 - x_i, 0\} \,..\, 1\{0, y_1 - y_i\} \,..\, 3\{x_q - x_p, slope(x_q - x_p)\}$ ..
        $7\{x_q - x_p, slope(x_q - x_p)\}$ ..
        $9\{0, y_j - y_9\} \,..\, j\{x_j - x_9, 0\}$,
    $i\{x_2 - x_i, 0\} \,..\, 2\{0, y_2 - y_i\} \,..\, 4\{x_q - x_p, slope(x_q - x_p)\}$ ..
        $8\{x_q - x_p, slope(x_q - x_p)\}$ ..
        $10\{0, y_j - y_{10}\} \,..\, j\{x_j - x_{10}, 0\}$.                % the s-curve

subroutine zcomp(index i)                                  % starting point
        (index p)                  % turning point ($x_p$ to be defined)
        (index j)                  % transition point (to be defined)
        (index k)                                           % ending point
        (var slope):                     % reciprocal of ending slope
% This subroutine is dual to scomp.
% It computes $x_p$, $x_j$, $y_j$ so that $x_k - x_j = slope \cdot (y_k - y_j)$
% and so that the following curve is consistent with an ellipse:
% $i\{0, y_p - y_i\} \,..\, p\{x_p - x_i, 0\} \,..\, j\{slope.(y_k - y_p), y_k - y_p\}$
$x_k - x_j = slope(y_k - y_j)$;
new aa, bb;   $aa = slope(y_p - y_i)$;   $bb = x_k - x_i - slope(y_k - y_i)$;
$y_j - y_i = -2aa \cdot bb(y_p - y_i)/(aa \cdot aa + bb \cdot bb)$;
$x_p - x_i = .5(bb \cdot bb - aa \cdot aa)/bb$.
```

```
subroutine zdraw(index i)                                  % starting point
        (index p)              % left turning point ($x_p$ to be defined)
        (index k)                                           % middle point
        (index q)             % right turning point ($x_q$ to be defined)
        (index j)                                           % ending point
        (var penht)                      % effective height of hpen used
        (var penwd)                   % effective pen width at point $k$
        (var slope):                 % reciprocal of slope at point $k$
% This subroutine is dual to sdraw.
new $w_{18}, w_{19}$;   $w_{18} = penwd$;   $w_{19} = penht$;
cpen;   $rt_0 x_5 = rt_{18} x_k$;   $lft_0 x_6 = lft_{18} x_k$;   $y_5 = y_6 = y_k$;
if $y_p > y_i$:   $top_{19} y_p = top_6 y_1$;   $bot_{19} y_p = bot_6 y_2$;
     $top_{19} y_q = top_6 y_9$;   $bot_{19} y_q = bot_6 y_{10}$;
else:   $bot_{19} y_p = bot_6 y_1$;   $top_{19} y_p = top_6 y_2$;
     $bot_{19} y_q = bot_6 y_9$;   $top_{19} y_q = top_6 y_{10}$;
fi;
$x_2 = x_p$;   $x_9 = x_q$;
call zcomp(i, 1, 3, 5, slope);                  % compute $x_1$ and point 3
call zcomp(i, 2, 4, 6, slope);                  % compute $x_2$ and point 4
call zcomp(j, 9, 7, 5, slope);                  % compute $x_9$ and point 7
call zcomp(j, 10, 8, 6, slope);              % compute $x_{10}$ and point 8
hpen;   $w_0$ ddraw $i\{0, y_1 - y_i\} \,..\, 1\{x_1 - x_i, 0\} \,..\, 3\{slope(y_q - y_p), y_q - y_p\}$ ..
        $7\{slope(y_q - y_p), y_q - y_p\}$ ..
        $9\{x_j - x_9, 0\} \,..\, j\{0, y_j - y_9\}$,
    $i\{0, y_2 - y_i\} \,..\, 2\{x_2 - x_i, 0\}$   $4\{slope(y_q - y_p), y_q - y_p\}$ ..
        $8\{slope(y_q - y_p), y_q - y_p\}$ ..
        $10\{x_j - x_{10}, 0\} \,..\, j\{0, y_j - y_{10}\}$.                % the s-curve

subroutine bar(index i, index j):
% This subroutine is similar to "vpen;   $w_3$ draw $i \,..\, j$",
% but the vpen slants with italic.
no proofmode;                         % the points computed aren't interesting
vpen;   $top_6 y_1 = top_9 y_i$;   $bot_6 y_2 = bot_9 y_i$;
$top_6 y_3 = top_9 y_j$;   $bot_6 y_4 = bot_9 y_j$;
$x_1 = x_2 = x_i$;   $x_3 = x_4 = x_j$;
$w_3$ ddraw 1 .. 3, 2 .. 4.

subroutine fstroke(index i)                                  % dot position
        (index j):                               % $x$-coordinate of stem
hpen;   $x_1 = x_j$;   $bot_1 y_j = 0$;   $y_1 = .5[m, h]$;
$rt_0 x_3 = rt_3 x_i$;   $y_3 = y_i$;
$x_2 = .5[x_1, x_3]$;   $top_0 y_2 = h + oo$;
draw $|w_1|j \,..\, |w_1\#|1\{0, 1\} \,..\, |w_0\#|2\{1, 0\} \,..\, 3\{0, -1\}$;   % shoulder and stem
cpen;   $w_3$ draw $i$;                                               % bulb
if $lcs \neq 0$:   call 'a serif(j, 1, 1, −lcs);
     call 'b serif(j, 1, 1, lcs);                                    % serif
fi.
```

```
subroutine hstroke(index i)                                          % x-coordin .te of left stem
           (index j)                                                 % x-coordinate of right stem
           (index k):                                         % will be set to base of right stem
hpen;   x_k = x_j;   bot_1 y_k = 0;
rt_0 x_1 = rt_1 x_i;   y_1 = 1/3[e, m];   y_j = 1/3[e, m];
x_2 = .5[x_i, x_j];   top_3 y_2 = m + oo;
x_3 = 1/sqrttwo[x_2, x_j];   y_3 = 1/sqrttwo[y_j, y_2];
draw |w_0|1{0, 1} .. |w_0#|2{1, 0} .. |.6[w_0, w_1]|3{x_j − x_2, y_j − y_2} ..
     |w_1#|j{0, −1} .. k.                                            % shoulder and stem

subroutine cdraw(index i, index j)                                           % given points
           (index p, index q):                                % given widths, w_p ≥ w_q
% An implementation of the forbidden "cpen;   draw |w_p|i .. |w_q|j".  ·
cpen;   w_p draw i;                                                  % plot the bigger dot
new aa;   (aa + eps) sqrt((x_j − x_i)(x_j − x_i) + (y_j − y_i)(y_j −− y_i)) = w_p − w_q;
x_2 − x_1 = aa(y_i − y_j);   y_2 − y_1 = aa(x_j − x_i);
x_i = .5[x_1, x_2];   y_i = .5[y_1, y_2];                       % perpendicular points
w_q ddraw 1 .. j, 2 .. j.                                            % fill in the rest

subroutine qcirc(index i)                                         % horizontal endpoint
      (index j)                                                  % intermediate point
      (index k)                                                    % vertical endpoint
      (var size):                          % size of cpen that draws a quarter ci:cle
cpen;   x_j = 1/sqrttwo[x_i, x_k];   y_j = 1/sqrttwo[y_k, y_i];
size draw i{x_k − x_i, 0} .. j{x_k − x_i, y_k − y_i} .. k{0, y_k − y_i}.

subroutine hcirc(index viii, index i, index ii, index iii, index iv, var size):
x_iv = x_viii;   y_ii == .5[y_iv, y_viii];
call qcirc(viii, i, ii, size);   call qcirc(iv, iii, ii, size).

subroutine circle(index i, index ii, index iii, index iv,
      index v, index vi, index vii, index viii, var size):
x_iv = x_viii = .5[x_vi, x_ii];   y_ii = y_vi = .5[y_iv, y_viii];
call qcirc(viii, i, ii, size);   call qcirc(iv, iii, ii, size);
call qcirc(iv, v, vi, size);   call qcirc(viii, vii, vi, size).

subroutine entry(var z)                               % x-coordinate for upward stroke
      (index j):                  % τ-coordinate for downward stroke (y_j will be set)
% This subroutine draws a little hook at the beginning left of an italic character,
% ending with the pen traveline vertically at point j with size w_1.
hpen;   x_1 = good_0 z;   y_1 = 1/4 m;   y_j = 3/4 m;   x_2 = x_j − 1.5u;   top_0 y_2 = m + oo;
draw |w_0|1{(x_j − 2.5u) − x_1, m} .. |w_0#|2{1, 0} .. |w_1#|j{0, −1}.
```

```
subroutine skewentry(var z)                          % x-coordinate for upward stroke
      (index j):                 % x-coordinate for downward stroke (y_j will be set)
% This subroutine is analogous to entry, but the pen starts out vertical
% and ends at the skewed slope {−u, −m} to compensate for optical illusion
hpen;   x_1 = good_0 z;   y_1 = 2/3 m;   y_j = 3/4 m,
x_2 = x_j − 1 25u;   top_0 y_2 = m + oo;
draw |w_0|1{0, 1} .. |w_0#|2{1, 0} .. |w_1#|j{−u, −m}.

subroutine exit(index i)           % x-coordinate for downward stroke (y_i will be set)
      (var z):                                       % x-coordinate for upward stroke
% This subroutine draws a little hook at the ending right of an italic character,
% beginning with the pen traveling vertically at point i with size w_1.
hpen;   x_2 = good_0 z;   y_2 = 1/3 m;   y_i = 1/4 m,   x_1 = x_i + 1 5u,   bot_0 y_1 = −oo,
draw |w_1#|i{0, −1} .. |w_0#|1{1, 0} .2{x_2 − (x_i + 2 5u), m}.

subroutine skewexit(index i)       % x-coordinate for downward stroke (y_i will be set)
      (var z):                                       % x-coordinate for upward stroke
% This subroutine is analogous to exit, but the pen begins with the skewed
% slope {−u, −m} to compensate for optical illusion, and ends vertically
hpen;   x_2 = good_0 z,   y_2 = 1/3 m;   y_i = 1/4 m,   x_1 = x_i + 1.25u,   bot_0 y_1 = −oo,
draw |w_1#|i{−u, −m} .|w_0#|1{1, 0} .2{0, 1}.

subroutine italhstroke(index i)                                      % starting point
           (index j):                    % x-coordinate of right stem (y_j will be set)
hpen;   x_1 = .6[x_i, x_j],   x_2 = x_j − .4u,   top_0 y_1 = m + oo,   y_2 = .75[e, y_1],
y_j = .3[e, m];
draw |w_0|i{0, 1} .. |w_0#|1{1, 0}   |.75[w_0, w_1]|2 .|w_1#|j{0, −1}.

subroutine pistroke:                         % makes the bar of pi, tau, variant omega
vpen;   x_1 = good_0(0);   y_1 = m − m/3 14159;
x_2 = 2u;   top_7 y_2 = m,   y_3 = y_2,   x_3 = r − 1.5u,
draw |w_0#|1{x_2 − x_1, 3 14159(y_2 − y_1)}   |w_7#|2{1, 0} .  3;                 % bar
cpen;   w_7 draw 3.                                           % make the end point round

subroutine endv(index i)·                        % draws final bulb starting at this point
cpen,   x_1 = x_i − u;   x_2 = x_i − 6u,   top_1 y_1 = m + oo;   y_2 = y_1,
hpen,   draw |w_0#|i{0, 1} .|w_1#|1(..2);                                       % stroke
cpen;   w_1 draw 1                                                               % bulb

subroutine max(var a, var b).                                     % sets acc = max(a, b)
new acc;
if a > b:   acc = a;
else:   acc = b;
fi.
```



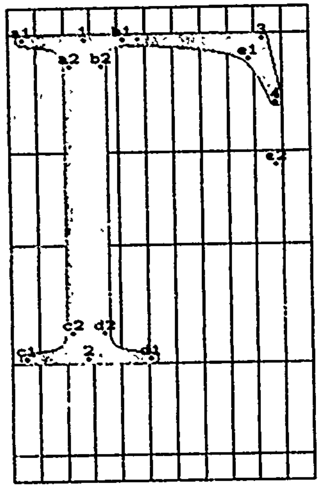
Frank and Ernest

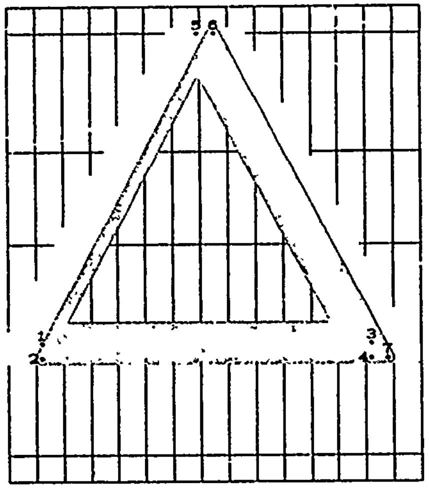
By Bob Thaves

ROMAN CHARACTEP DESIGNS

The file roman mf

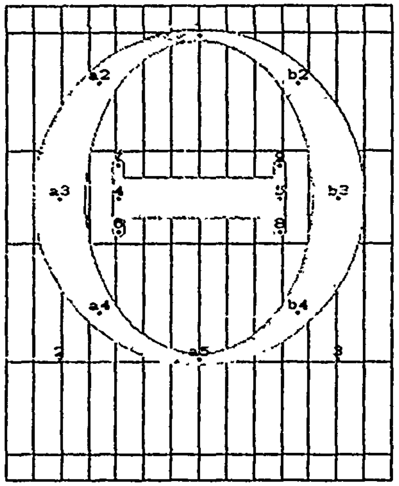
```
% The Computer Modern Rom.. ı family of fonts (by D  E  Knuth, 1979)
danger == mi == 0;
input rom.: ;                                                      % upper case (majuscules)
input romanl;                                                      % lower case (minuscules)
input romand;                                   % numerals, ampersand, and question mark
input romans;                                          % miscellaneous letter combinations
input romitp;                          % punctuation symbols common to all roman and italic
input romita;                   % accents and other symbols common to roman and italic text
if ligs ≠ 0:  input romlig;                            % letter ligatures (codes '173 '177)
    input romitl;                                          % ligatures common with italic
    input romext;                          % nonstandard characters (codes '043, '044)
else  input romits,                                            % substitutes for ligatures
fi;
if fixwidth = 0:  new k, kk, kkk;                            % three degrees of kerning
    k == -.5pu;  kk == -1.5pu;  kkk == --2 5pu;
    lig `k:  `v:  `w:  `x:  `y:
        `o kern k, `e kern k, `c kern k;
    lig `F:  `V:
        `A kern kkk, `o kern kk, `e kern kk,
        `a kern kk, `u kern kk, `r kern kk,
    `K:  `X:
        `O kern k, `C kern k, `G kern k, `Q kern k;
    lig `T.  `y kern kk,
    `Y:  `o kern kk, `e kern kk,
        `a kern kk, `u kern kk, `r kern kk,
    `P.  `W:  `A kern kk;
    lig `O:  `A kern k, `W kern k, `Y kern k, `V kern k, `X kern k;
    if lcs ≠ 0·  lig `h   `m:  `n:
        `t kern k, `u kern k, `b kern k,;
    fi,
    lig `o
        `v kern k, `x kern k, `y kern k,
    `t
        `w kern k;
    if ucs ≠ 0:  lig `R.  ,
    fi,
    lig `A   `t kern k, `L
        `T kern kk, `O kern k, `U kern k, `C kern k,
        `W kern kk, `Y kern kk, `G kern k, `V kern kkk,
        `Q kern k;
    texinfo slant, 6pu, 3pu, 2pu, px, 18pu, 2pu;
else:  texinfo slant, 9pu, 0, 0, px, 9pu, 9pu;
fi.
```

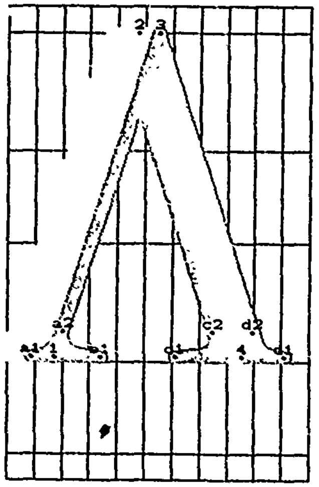




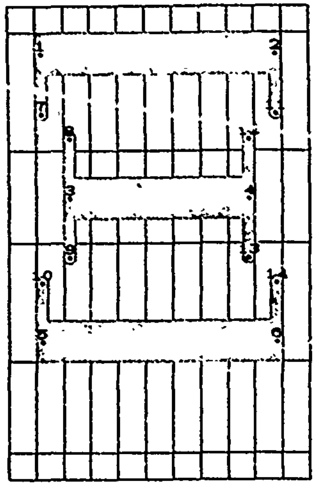
The file romitu mf

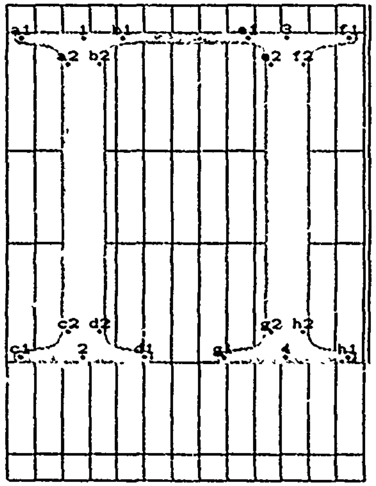
```
% These upper-case Roman and Greek alphabets were prepared by D. E. Knuth in November,
% 1979, inspired by the Monotype alphabets used in The Art of Computer Programming.
% For text spacing, set mi = 0; for math spacing, set mi = 1.
% Character codes '000--'012 and '101--'132 are generated.

new mc, lbowl, rbowl, rstem, rv, hic;                      % quantities used to compute spacing
mc = mi/pu,                                             % converts to relative units when mi = 1
lbowl = .3ph·slant + .5pu;                                   % used at left of upper-case bowl
rbowl = 7ph·slant − 5pu;                                    % used at right of upper-case bowl
rstem = ph·slant + (ucs + 2sc − 1.5)pu;                           % used at right of tall stem
rv = ph·slant + (.5ucs + 2sc − 1)pu;                           % used at right of tall diagonal
hic = 1 − .5mi;                          % used when half the italic correction goes into itcorr

"Upper case Greek Gamma";
call charbegin('000, 11, 2sc, sc − mc(armic − 2 5pu), ph, 0, mi[armic, 2.5pu]);
hpen;   lft_1 x_1 = round 2u;   x_2 = x_1;   top_1 y_1 = h;   bot_1 y_2 = 0;
w_1 draw 1..2;                                                                           % stem
if ucs ≠ 0:
     call 'a serif(1, 4, 2, −ucs);
     call 'b serif(1, 4, 2, .5ucs);                                            % upper stem serif
     call 'c serif(2, 4, 1, −ucs);
     call 'd serif(2, 4, 1, ucs);                                              % lower stem serif
fi;
new ss;   ss = 1.4aspect·ucs·u + eps,
if ss + w_1 > .25h:   new ss;   ss = .25h − w_1 + eps,
fi;
rt_0 x_3 = round(r − 1 5u),   x_4 = x_3 + 5u,   y_3 = y_1,   y_4 = y_3 − ss;
call 'e arm(1, 3, 4).                                                  % upper arm and serif

"Upper case Greek Delta";
call charbegin('001, 15, 0, 0, ph, 0, 0);
hpen;   lft_0 x_2 = round u;   rt_1 x_1 = round(r − u),   bot_0 y_2 = 0;   bot_1 y_1 = 0;
top_1 y_5 = h + o;   y_6 = y_5;
x_6 − x_2 = x_1 − x_5;   rt_1 x_5 = rt_0 x_6;   x_3 = x_2,   x_4 = x_1,
vpen;   bot_5 y_3 = 0;   y_4 = y_3;
w_0 draw 1..3,                                                                       % bar line
rpen#;   w_0 draw 5..4;                                                % erase excess at lower right
hpen;   w_1 draw 5. 4;                                                            % right diagonal
lpen#,   w_1 draw 6. 2;   w_0 draw 6   2;                                    % erase excess at left
hpen;   w_0 draw 6..2,                                                             % left diagonal
y_7 = y_1;   rt_0 x_7 = rt_1 x_1;
w_0 draw 2..7..7..6.                                                % sharpen lower right corner
```



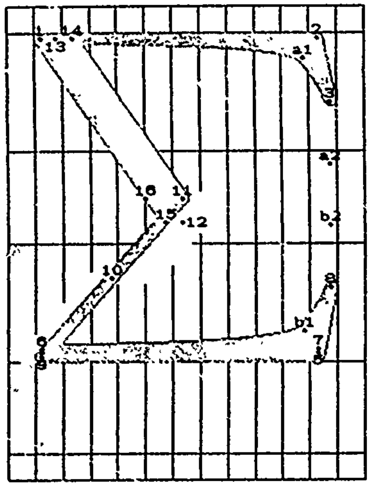


```
'Upper case Greek Theta";
call charbegin('002, 14, mc lbowl, −mc rbowl, ph, pdd, mi[rbowl, 0]);
hpen;
if fixwidth ≠ 0:   new save;   save = sqrttwo;
     new sqrttwo;   sqrttwo = sqrt save;                     % super-superellipse
     lft_5x_2 = round 1.5u;
else   lft_5x_2 = round u;
fi,                                                         % axis of left-right symmetry
x_1 = r − x_1;
top_0y_1 = h + oo;
bot_0y_2 = −oo;   y_3 = y_2,   x_1 = r − x_2,              % left part of bowl
call `a darc(1, 2, w_5);                                    % right part of bowl
call `b darc(1, 3, w_5);
lft_0x_1 = round(rt_5x_2 + u),   x_5 = r − x_1;   y_1 = y_5 = .5[y_1, y_2];
vpen,                                                       % bar line
if ucs = 0:   w_0 draw 4..5;                                % bar line
else:   call bar(4,5);
     x_6 = x_7 = x_1;   x_8 = x_9 = x_5;   y_7 = y_9 = .6h;   y_6 = y_8 = .4h,
     w_0 draw 6. 7;                                         % left serif
     draw 8..9;                                             % right serif
fi;
if fixwidth ≠ 0:   new sqrttwo;   sqrttwo = save;
fi.

"Upper case Greek Lambda ·
call charbegin('003, 11, 2sc, 2sc, ph, 0, 0),
hpen;   lft_0x_1 = round 1 5u;   bot_0y_1 = 0;
rt_5x_1 = round(r − 1.5u);   bot_5y_1 = 0;
top_0y_3 = top_5y_2 = h + o;
x_3 − x_1 = x_1 − x_2;   rt_5x_2 = rt_0x_3,
w_5 draw 2..4;                                              % right diagonal stroke
lpen#;   w_5 draw 3..1,                                     % erase exce s at upper left
hpen;   w_0 draw 3..1;                                      % left diagonal stroke
if ucs ≠ 0:
     call `a serif(1, 0, 3, −.5ucs);                        % left serifs
     call `b serif(1, 0, 3, +ucs);
     call `c serif(4, 5, 2, −ucs);                          % right serifs
     call `d serif(4, 5, 2, + 5ucs):
fi.
```

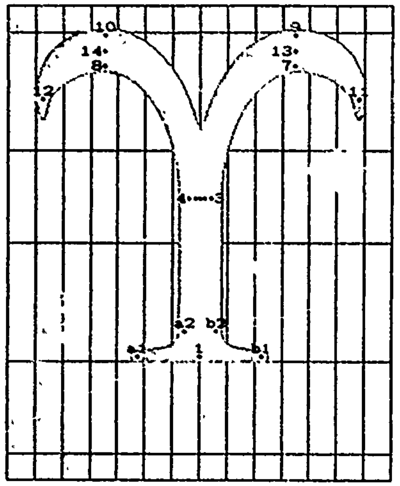




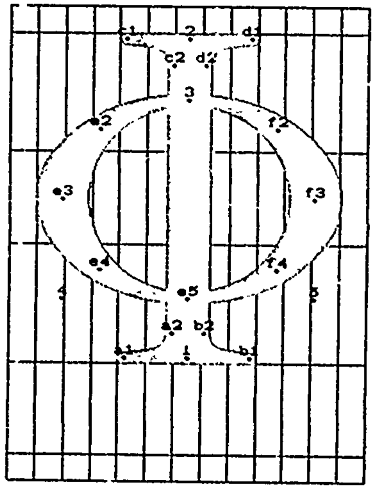
```
"Upper case Greek Xi";
call charbegin('004, 11, 0, — 5mc(ph·slant — 5pu), ph, 0, hic(ph·slant — 5pu));
vpen;   top8y1 = h,   y1 = y2;   y3 = y4 = good8 5h;   bot8y5 = 0,   y5 = y6,
lft8x1 = round u;   rt8x2 = round(r — u);   x5 = x1   x6 = x2;
lft8x3 = round 2u;   rt8x4 = round(r — 2u);
if ucs = 0:   w6 draw 1..2;                                          % upper bar
     draw 3..4;                                                      % middle bar
     draw 5..6;                                                      % lower bar
else:   call bar(1, 2);                                              % upper bar
     call bar(3, 4);                                                 % middle bar
     call bar(5, 6);                                                 % lower bar
     new ss;   ss = ucs·aspect u + eps;
     if ss > 2h   new ss;   ss = .2h + eps;
     fi;
     x7 = x10 = x1;   x8 = x9 = x3,   x11 = x14 = x2;   x12 = x13 = x4,
     bot6y7 = bot8y1 — ss;   top6y8 = top8y3 + ss:
     bot6y9 = bot8y3 — ss;   top6y10 = top8y5 + ss;
     y11 = y7;   y12 = y8;   y13 = y9,   y14 = y10;
     w6 draw 7..1;   draw 11. 2;                                     % upper serifs
     draw 8. 9,   draw 12   13;                                      % middle serifs
     draw 10   5,   draw 14 .6,                                      % lower serifs
fi.

"Upper case Greek Pi";
call charbegin('005, 13, 2sc, 2sc — 5mc rstem, ph, 0, hic rstem);
hpen;   lft1x1 = round 2u;   x2 = x1;
rt1x3 = round(r — 2u);   x4 = x3;
top1y1 = h;   y1 = y3;
bot1y2 = 0;   y2 = y4;
w1 draw 1..2;                                                        % left stem
w1 draw 3..4;                                                        % right stem
if ucs ≠ 0:   call `a serif(1, 4, 2, —ucs);
          call `b serif(1, 4, 2, .5ucs);                             % upper left serif
     call `c serif(2, 4, 1, —ucs);
          call `d serif(2, 4, 1, ucs),                               % lower left serif
     call `e serif(3, 4, 4, — 5ucs);
          call `f serif(3, 4, 4, ucs);                               % upper right serif
     call `g serif(4, 4, 3, - —ucs),
          call `h serif(4, 4, 3, ucs);                               % lower right serif
fi;
w0 draw 1..3.                                                        % bar
```



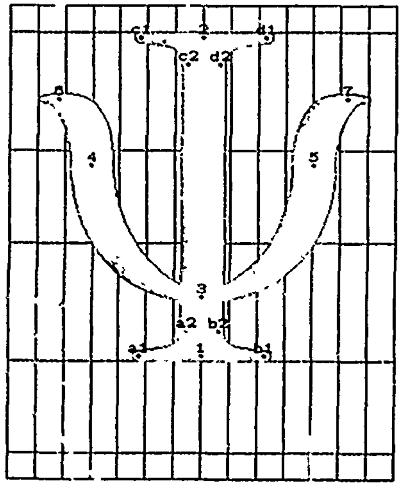
```
"Upper case Greek Sigma";
call charbegin('006, 13, 0, sc − .5mc armic, ph, 0, hic·armic);
new w99,   w99 = round 25[w6, w9];
hpen,   lft0x1 = round u;   rt0x2 = round(r − 1 5u);   x3 = x2 + .5u;
new ss;   ss = 1.4aspect·ucs·u + eps;
if ss + w6 > 25h:   new ss;   ss = .25h − w6 + eps;
fi;
top0y1 = h,   y2 = y1;   y3 = y2 − ss;
vpen;   bot99y4 = 0;   y5 = y4;   top6y6 = top99y1,   y7 = y6,   y8 = y7 + ss;
x4 = x6 = x1,   x5 = x7 = x2;   x8 = x3;
call `a arm(1, 2, 3);                                          % upper arm and serif
call `b arm(6, 7, 8);                                          % lower arm and serif
w99 draw 4. 5;
if ucs = 0:   draw 5..8;                                       % thicken lower arm
else:   if w0 ≠ w1:   draw |w99|5   |w6|8;                     % thicken lower arm
     else:   draw 5..8;                                        % thicken lower arm
     fi;
fi,
hpen;   x9 = x1;   x10 = .5[x9, x11];   x16 = round 5u, . lft1x12 = lft0x15,
lft1x99 = x16;   rt1x99 = rt0x11;   lft1x14 = lft0x1,   rt1x11 = rt0x11,
bot0y9 = 0;   y10 = .5[y9, y11],   y11 = y16 = .5h,   y12 = y15,   y13 = y14 = y1,
new aa, bb;   lft0x15 = aa[lft0x1, x16],   y15 = aa[y1, y16],
lft0x13 = bb[x9, x11];   y13 = bb[y9, y11];
w1 draw 13. 12;                                                % upper diagonal
w0 draw 1..15;                                                 % sharpen upper left corner
rpen#;   w1 draw 10..11;                                       % erase excess at right
lpen#;   w99 draw 9..10,                                       % erase excess at left
hpen;   w0 draw 9 .11;                                         % lower diagonal
draw 14..11                                                    % sharpen middle corner
```

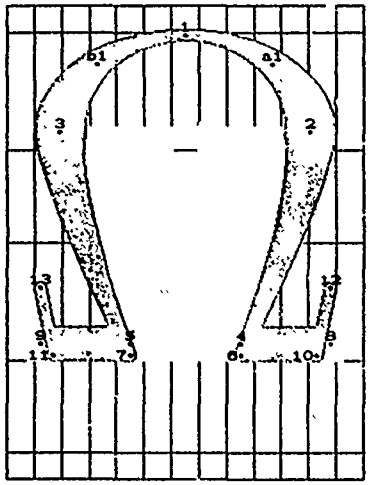


6
2
5

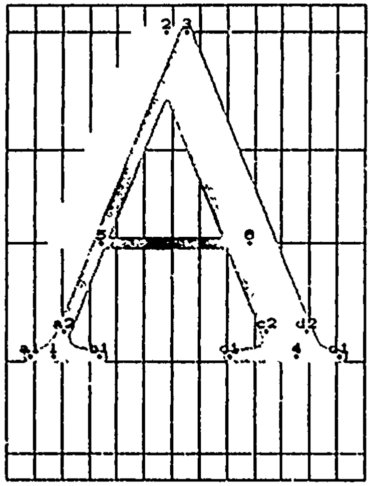


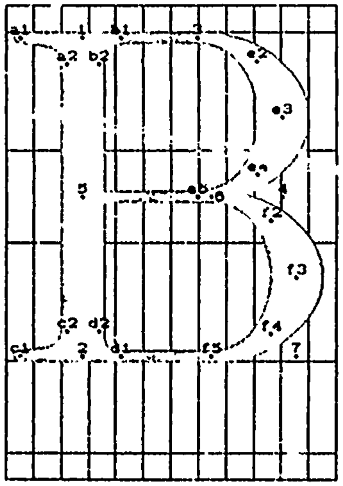
```
'Upper case Greek Upsilon";
call charbegin('007, 14, mc(.8ph·slant + 5pu), —mc( 8ph slant — 3pu),
                ph, 0, mi[.8ph·slant — 5pu, 2 5pu]);
hpen;   x1 = good1.5r;   bot1y1 = 0,   x2 = x1;   y2 = 5h;
w1 draw 1..2;                                                          % stem
if ucs ≠ 0.   call `a serif(1, 4, 2, —ucs),
     call `b serif(1, 4, 2, ucs);                                      % serif
fi;
new w99;   w99 = round .5w1;
rt99x3 = rt1x2;   lft99x4 = lft1x2;
lft99x5 = x2 — .25u;   x7 = x9 = x11 = 10.5u;
vpen;   rt8x11 = round(r — u);   y11 = 8h;
top8y13 = top6y9 = h + oo;   bot8y13 = bot6y7;
y3 = y4 = y5 = y6 = y2;   y7 = y8;   y9 = y10;   y11 = y12,   y13 = y14.
x3 + x4 = x5 + x6 = x7 + x8 = x9 + x10 = x11 + x12 = x13 + x14,  % left-right symmetry
w9 draw 13{1, 0}. 11{0, —1};                                          % right stroke
draw 14{—1, 0}..12{0, —1};                                             % left stroke
hpen;   w99 ddraw 5{0, 1}..9{1, 0}, 3{0, 1}. 7{1, 0};
ddraw 6{0, 1} .10{—1, 0}, 4{0, 1}..8{—1, 0}                           % middle strokes

"Upper case Greek Phi";
call charbegin('010, 13, mc( 5ph·slant + 5pu), —mc(.5ph·slant — .5pu),
                ph, 0, mi[ 5ph slant — .5pu, 0]);
hpen;   x1 = good1.5r;   bot1y1 = 0;   x2 = x1;   top1y2 = h;
w1 draw 1..2;                                                          % stem
if ucs ≠ 0:   call `a serif(1, 4, 2, —ucs);
     call `b serif(1, 4, 2, ucs);                                      % upper serif
     call `c serif(2, 4, 1, —ucs);
     call `d serif(2, 4, 1, ucs);                                      % lower serif
fi;
x3 = x1;   y3 = .8h;   y4 = y5 = 2h;
lft5x4 = round u;   x3 — x4 = x5 — x3,                                 % left-right symmetry
call `e darc(3, 4, w5),   call `f darc(3, 5, w5).                      % bowl
```



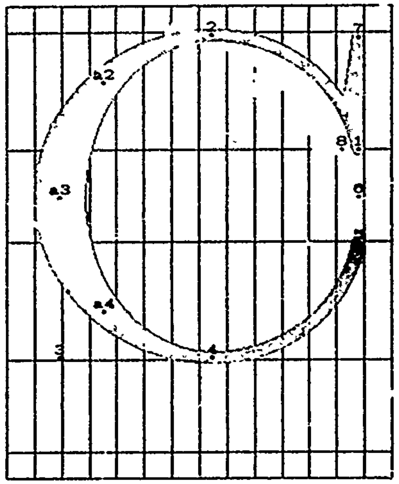


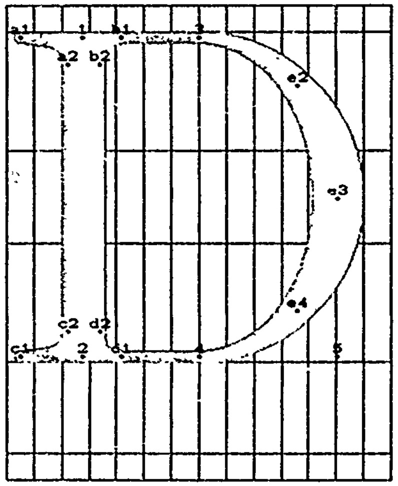
```
"Upper case Greek Psi",
call charbegin('011, 14, mc(.8ph slant + .5pu), − 5mc(.8ph slant − .5pu),
                    ph, 0, hic(.8ph·slant − .5pu));
hpen;   x1 = good1.5r,   bot1y1 = 0;   x2 = x1;   top1y2 = h;
w1 draw 1..2;                                                        % stem
if ucs ≠ 0:   call `a serif(1, 4, 2, −ucs);
      call `b serif(1, 4, 2, ucs);                                   % upper serif
      call `c serif(2, 4, 1, −ucs);
      call `d serif(2, 4, 1, ucs);                                   % lower serif
fi;
x3 = x1;   y3 = .2h;   lft1x6 = u;   x4 = good1.3u;   y4 = .6h;   y6 = .8h
y4 = y5,   y6 = y7,   x1 − x4 = x5 − x1,   x1 − x6 = x7 − x1,        % left-right symmetry
w1 draw 6{1, 0}..4{0, −1}..3{1, 0};                                  % left stroke
draw 7{−1, 0}..5{0, −1}..3{−1, 0}.                                   % right stroke

"Upper case Greek Omega";
call charbegin('012, 13, mc(¾pe slant + .5pu), − 5mc(.75ph·slant − .5pu),
                    ph, 0, hic(.75ph·slant − .5pu));
hpen;   top0y1 = h + oo;   y2 = .7h;   rt5x2 = rt0x8 = round(r − u);
vpen;   bot7y8 = bot6y6 = 0;   y4 = y8,   x4 = x6 = good0.85u;
x1 + x1 = x2 + x3 = x4 + x5 = x6 + x7 = x8 + x9 = r;                 % left-right symmetry
y2 = y3;   y4 = y5;   y6 = y7,   y8 = y9;
w7 draw 4..8;                                                        % right bar
draw 5..9;                                                           % left bar
lpen#;   x0 − x7 draw 2{0, −1}..6{x6 − x2, 4/7(y6 − y2)};            % erase middle
rpen#;   x0 − x7 draw 3{0, −1}..7{x7 − x3, 4/7(y7 − y3)};            % ditto
call `a arc(1, 2, w5);   call `b arc(1, 3, w5);                      % bowl
hpen;   draw |w5|2{0, −1}..|w0|6{x6 − x2, 4/7(y6 − y2)},             % right diagonal
draw |w5|3{0, −1}..|w0|7{x7 − x3, 4/7(y7 − y3)};                     % left diagonal
if ucs ≠ 0:   x12 = x8;   bot0y10 = 0;   top0y12 = ⅓e;
      x10 + x11 = x12 + x13 = r;   y10 = y11,   y12 = y13;
      if w7 = w0:   x10 = x12;
      else:   x10 + .5u = x12;
            rpen#;   .5u + w0 draw 10..12,                           % erase excess at right
            lpen#;   .5u + w0 draw 11..13;                           % erase excess at left
      fi;
      hpen;   w0 draw 10..12,   draw 11..13;                         % serifs
fi
```



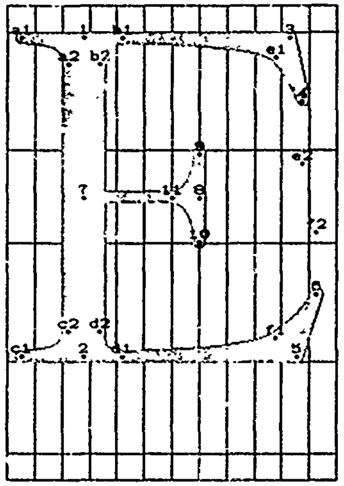


```
"The letter A";
call charbegin(`A, 13, 2sc, 2sc, ph, 0, 0);
hpen;
lft0x1 = round 1.5u;   bot0y1 = 0;
rt5x1 = round(r − 1.5u);   bot5y1 = 0;
top0y3 = top5y2 = h + o;
x1 − x1 = x1 − x2;   rt5x2 = rt0x3;
w5 draw 2..4;                                         % right diagonal stroke
y5 = y6 = c;
new aa, bb;                     % auxiliary variables for intersection of lines
x5 − 1 = aa[x1, x1];   y5 = aa[y1, y3];
x6 + 1 = bb[x1, x2];   y6 = bb[y1, y2];
w0 draw 5..6;                                                   % bar line
lpen#;   w5 draw 2..5;                           % erase excess at upper left
hpen,   w0 draw 3..1,                                 % left diagonal stroke
if ucs ≠ 0:
     call `a serif(1, 0, 3, − 5ucs);
     call `b serif(1, 0, 3, + ucs);                             % left serifs
     call `c serif(4, 5, 2, − ucs);
     call `d serif(4, 5, 2, + 5ucs);                           % right serifs
fi.

"The letter B";
call charbegin(`B, 12, 2sc, − 5mc(.75ph·slant − .5pu), ph, 0, lm(.75ph slant − .5pu));
hpen;   lft1x1 = lft1x2 = round 2u,   top1y1 = h;
bot1y2 = 0;
w1 draw 1..2;                                                       % stem
if ucs ≠ 0:
     call `a serif(1, 4, 2, − ucs);
     call `b serif(1, 4, 2, 5ucs);                              % upper serif
     call `c serif(2, 4, 1, − ucs);
     call `d serif(2, 4, 1, 5ucs);                              % lower serif
fi;
x1 = ½[2u, r];   y3 = y1;
rt5x1 = round(r − u);   y1 = good0 ½h,
w0 draw 1..3;                                             % upper bar line
call `e darc(3, 4, w5);                                       % upper bowl
x5 = x1;   x6 = x1 + ½u,   y6 = y5 = y6,
rt5x7 = round(r − ½u);   bot5y7 = 0;
w0 draw 5..6;                                            % middle bar line
call `f darc(6, 7, w5);                                       % lower bowl
x4 = x6,   y8 = y7;   w0 draw 2..8.                        % lower bar line
```

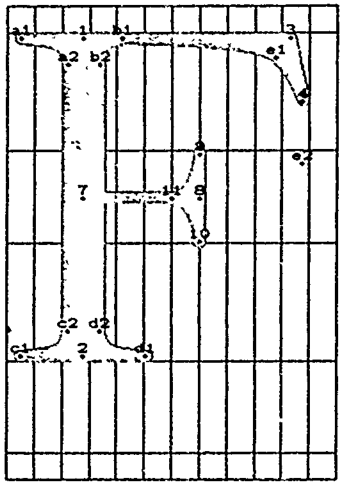




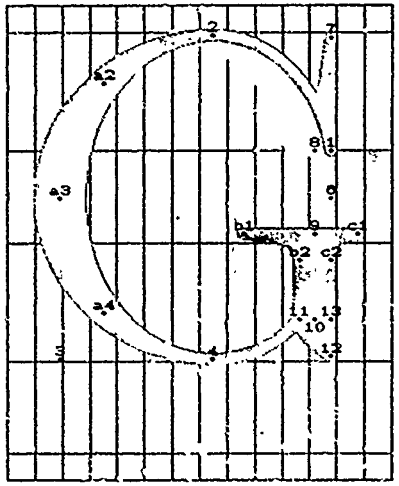
```
'The letter C";
if ucs ≠ 0:   call charbegin(`C, 14, mc lbowl, -- 5mc(ph·slant -- 5pu),
                    ph, 0, hic(ph slant — 5pu));
else:   call charbegin(`C, 11, mc·lbowl, -- 5mc(ph slant — 5pu),
                    ph, 0, hic(ph slant — 5pu));
fi,
hpen;
rt_0 x_1 = round(r -- u);   x_5 = x_1;   lft_5 x_3 = round u;   x_2 = x_1 = 7 5u;
top_0 y_2 = h + oo;   bot_0 y_3 = —oo;   y_3 = y_1,   y_6 = 5[y_2, y_3],
if ucs = 0:   x_0 = 13u;   new aa,   x_1 = aa[x_2, x_0],
     y_1 = (sqrt(1 — aa·aa))[y_6, y_2];
else.   if m < .6h    y_1 = good_6 2/3h,   else    y_1 = good_6 m,
     fi;
     x_6 = x_1;   x_7 = x_1,   top_0 y_7 = h,   lft_0 x_8 = lft_1 x_1;   y_8 = y_1,
     w_0 ddraw 1. 7,8..7;                                        % upper serif
     ipen#;   w_1 draw (6   )1   2{—1,0},                        % erase spurious part
fi;
hpen,   y_5 = h — y_1;
w_0 draw (6   )1..2{—1,0};                                       % upper right stroke
call `a darc(2, 3, w_2);                                          % main stroke
w_0 draw 4{1,0}   5(..6).                                        % lower right stroke

"The letter D";
call charbegin(`D, 14, 2sc, —mc·rbowl, ph, 0, mi[rbowl, 0]);
hpen;   lft_1 x_1 = round 2u;   x_2 = x_1,   top_1 y_1 = h,   bot_1 y_2 = 0,
w_1 draw 1   2;                                                   % stem
if ucs ≠ 0:
     call `a serif(1, 4, 2, —ucs);
     call `b serif(1, 4, 2, .5ucs);                               % upper serif
     call `c serif(2, 4, 1, —ucs);
     call `d serif(2, 4, 1, 5ucs);                                % lower serif
fi;
x_3 = x_4 = 7u,   rt_5 x_5 = round(r — u),
y_3 = y_1;   y_4 = y_5 = y_2;
w_0 draw 1..3;                                                   % upper bar line
call `e darc(3, 5, w_5);                                          % bowl
w_0 draw 4   2                                                   % lower bar line
```



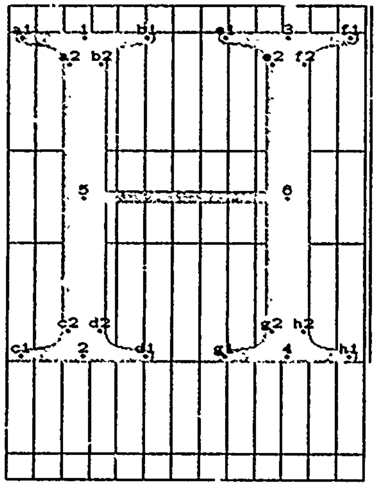
```
"The letter E";
call charbegin(`E, 12, 2sc, sc — .5mc armic, ph, 0, hic·armic);
hpen;  lft1x1 = round 2u;  x2 = x1;  top1y1 = h;  bot1y2 = 0,
w1 draw 1..2;                                                       % stem
if ucs ≠ 0:
     call `a serif(1, 4, 2, —ucs);
     call `b serif(1, 4, 2, 5ucs);                                  % upper stem serif
     call `c serif(2, 4, 1, —ucs);
     call `d serif(2, 4, 1, 5ucs);                                  % lower stem serif
fi;
new ss,  ss = 1.4aspect ucs·u + eps;
if ss + w6 > .25h.  new ss;  ss = .25h - w6 + eps;
fi;
rt0x3 = round(r — 1.5u),  x4 = x3 + 5u;  y3 = y1,  y4 = y3 — ss,
rt0x5 = round(r — 1 25u),  x6 = x5 + 5u;  y5 = y2,  y6 = y5 + ss;
call `e arm(1, 3, 4);                                          % upper arm and serif
call `f arm(2, 5, 6);                                          % lower arm and serif
x7 = x1;  y7 = y8 = .5[y1, y2];  x8 = good0 7u;
w0 draw 7..8;                                                       % middle arm
if ucs ≠ 0:  x9 = x10 = x8;  y9 = y8 + 7ss,  y10 = y8 — 7ss,
     if w0 = w1:  w0 draw 9..10;                                    % middle arm serif
     else:  x11 = x8 — u;  y11 = y8;
          minvr 0;  minvs 0;
          w0 ddraw 11{1,0}..10{0,—1},8..10;
          ddraw 11{1,0}..9{0,1},8..9;                               % middle arm serif
          minvr .5;  minvs .5;
     fi;
fi.
```

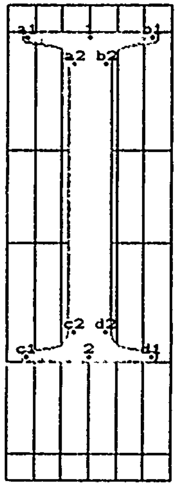


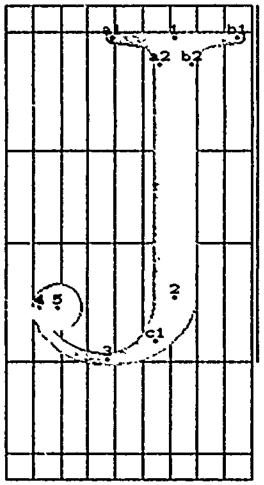
```
"The letter F";
call charbegin(`F, 12, 2sc, sc − mc(armic − 2.5pu), ph, 0, mi[armic, 2.5pu]);
hpen;   lft4x1 = round 2u;   x2 = x1;   top1y1 = h;   bot1y2 = 0,
w1 draw 1..2;                                                    % stem
if ucs ≠ 0:
     call `a serif(1, 4, 2, −ucs);
     call `b serif(1, 4, 2, .5ucs);                  % upper stem serif
     call `c serif(2, 4, 1, −ucs);
     call `d serif(2, 4, 1, ucs);                    % lower stem serif
fi;
new ss,   ss = 1.4aspect·ucs·u + eps;
if ss + w6 > .25h:   new ss;   ss = .25h − w6 + eps,
fi;
rt0x3 = round(r − 1.5u);   x4 = x3 + .5u,   y3 = y1,   y4 = y3 − ss;
call `e arm(1, 3, 4);                              % upper arm and serif
x7 = x1,   y7 = y8 = .5[y1, y2],   x8 = good0 7u,
w0 draw 7..8;                                               % lower arm
if ucs ≠ 0:   x9 = x10 = x8;   y9 = y8 + .7ss,   y10 = y8 − .7ss;
     if w0 = w1:   w0 draw 9..10,                  % lower arm serif
     else:   x11 = x8 − u;   y11 = y8;
          minvr 0;   minvs 0;
          w0 ddraw 11{1,0} .. 10{0, −1}, 8 .. 10;
          ddraw 11{1, 0} .. 9{0, 1}, 8 .. 9;          % lower arm serif
          minvr .5,   minvs .5,
     fi;
fi.
```



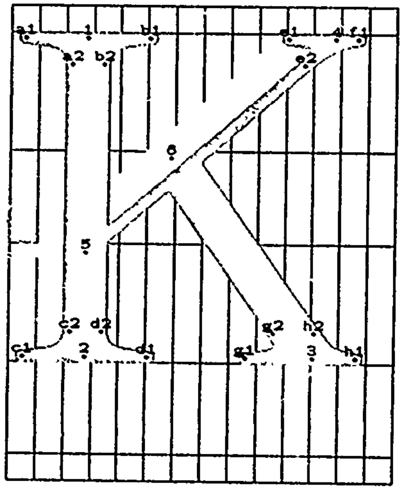
```
"The letter G";
if ucs = 0:  if m < .6h:  call charbegin(`G, 14, mc·lbowl,
                               sc − mc(⅓ph·slant + (sc − 1.5)pu),
                               ph, 0, (1 − mi)(⅓ph·slant + (sc − 1.5)pu));
     else:  call charbegin(`G, 14, mc·lbowl,
                               1 − mc(px·slant + (sc − 1.5)pu),
                               ph, 0, (1 − mi)(px·slant + (sc − 1.5)pu));
     fi;
else:  call charbegin(`G, 14, mc·lbowl,
                         sc − mc(ph·slant + (sc − 1.5)pu),
                         ph, 0, (1 − mi)(ph·slant + (sc − 1.5)pu));
fi;
hpen;
rt0x1 = rt1x0 = round(r − 2u);  lft5x3 = round u,  x2 = x1 = 7.5u,
top0y2 = h + oo,  bot0y3 = −oo,  y3 = y1;  y5 = .5[y2, y1];
if m < .6h:  y1 = good0 ⅔h;  else:  y1 = good0m,
fi;
x6 = x1,  y6 = good0 .1[e, m];  x9 = x10;
if ucs ≠ 0:  x7 = x1;  top0y7 = h;  lft0x8 = lft1x1,  y8 = y1,
     w0 ddraw 1..7, 8..7;                                   % upper serif
     lpen#;  w1 draw (6..)1..2{−1, 0},                      % erase spurious part
fi;
hpen;  w0 draw (6..)1..2{−1, 0};                            % upper right stroke
call `a darc(2, 3, w5);                                     % main stroke
if w0 = w1:  w0 draw 4{1, 0}..9{0, 1};                      % lower right stroke
     bot0y10 = 0;  draw 9..10;                              % stem and spur
else:  y11 = y10 = y13 = ⅓y6;
     lft0x11 = lft1x9;
     rt0x12 = rt0x13 = rt1x9;  bot0y12 = 0;
     w0 draw 4{1, 0}..11..9{0, 1};                          % lower right stroke
     w1 draw 9..10;                                         % stem
     w0 ddraw 13..12, 11{0, −1}..12{2(x12 − x11), y12 − y11};  % spur
fi;
if ucs < 2:  call `b serif(9, 4, 10, −2);
else:  call `b serif(9, 4, 10, −ucs);                       % lower serif
fi;
if ucs > 0  call `c serif(9, 4, 10, +1),
fi
```

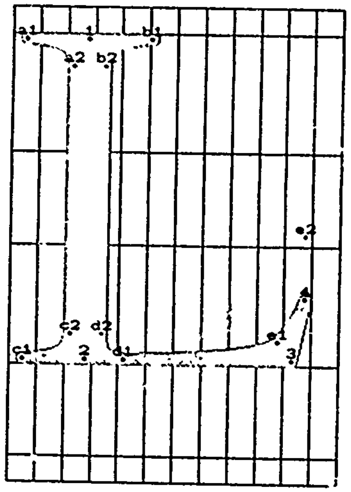




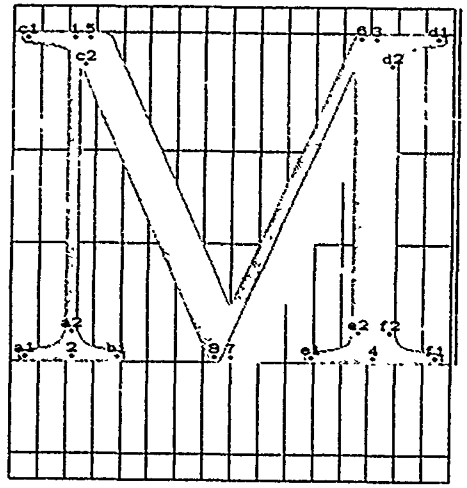


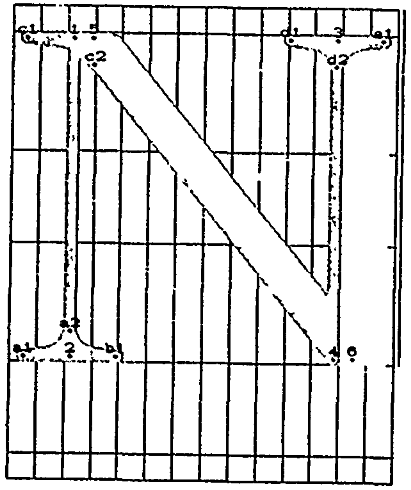
```
"The letter H";
call charbegin(`H, 13, 2sc, 2sc — .5mc·rstem, ph, 0, hic·rstem);
hpen;   lft_1 x_1 = round 2u,   x_2 = x_1,
rt_1 x_3 = round(r — 2u);   x_4 = x_3;
top_1 y_1 = h;   y_1 = y_3;
bot_1 y_2 = 0;   y_2 = y_4;
w_1 draw 1..2;                                                   % left stem
w_1 draw 3..4;                                                   % right stem
if ucs ≠ 0:   call `a serif(1, 4, 2, —ucs),
          call `b serif(1, 4, 2, ucs);                           % upper left serif
     call `c serif(2, 4, 1, —ucs);
          call `d serif(2, 4, 1, ucs);                           % lower left serif
     call `e serif(3, 4, 4, —ucs);
          call `f serif(3, 4, 4, ucs),                           % upper right serif
     call `g serif(4, 4, 3, —ucs);
          call `h serif(4, 4, 3, ucs),                           % lower right serif
fi;
x_5 = x_1;   x_6 = x_3;   y_5 = y_6 = .5h;
w_0 draw 5..6.                                                   % bar

"The letter I";
call charbegin(`I, 6, 0, — .5mc(ph·slant — .5pu), ph, 0, hic(ph·slant — .5pu));
hpen;   x_1 = x_2 = good_1 .5r;   top_1 y_1 = h;   bot_1 y_2 = 0;
w_1 draw 1..2;                                                   % stem
new ss;
if ucs ≠ 0:   ss = ucs;   else   ss = 2 — .5w_1/u;
fi;
call `a serif(1, 4, 2, —ss);   call `b serif(1, 4, 2, ss);       % upper serif
call `c serif(2, 4, 1, —ss);   call `d serif(2, 4, 1, ss).       % lower serif

"The letter J";
call charbegin(`J, 9, 0, 2sc — .5mc·rstem, ph, 0, hic·rstem),
hpen,   rt_1 x_1 = round(r — 2u),   top_1 y_1 = h;   y_2 = .2h,   x_2 = x_1,
w_1 draw 1..2;                                                   % stem
if ucs ≠ 0:   call `a serif(1, 4, 2, —ucs),
     call `b serif(1, 4, 2, ucs);                                % serif
fi;
lft_0 x_4 = lft_1 x_5 = round u,   y_4 = y_5 = 1/6 h,
x_3 = .5[x_1, x_2];   bot_0 y_3 = —oo;
call `c arc(3, 2, w_1);                                          % tail
w_0 draw 3{—1, 0}..4{0, 1};   cpen;   w_1 draw 5.                % bulb
```



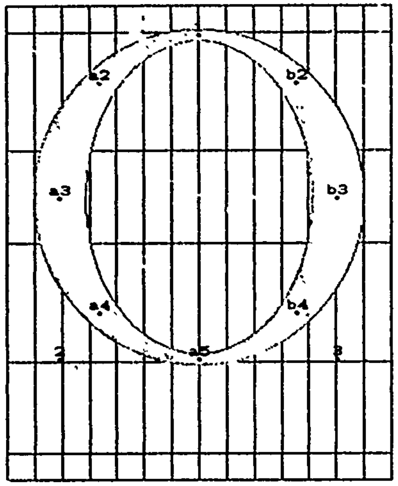


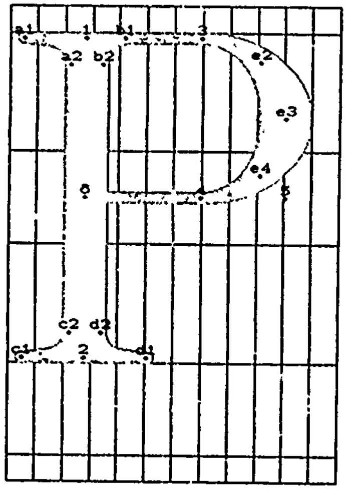
```
"The letter K";
call charbegin(`K, 14, 2sc, 2sc − .5mu(ph slant + (.5ucs + 2sc − 1.5)pu),
                     ph, 0, hu(ph slant + (.5ucs + 2sc − 1.5)pu));
hpen;  lft1x1 = round 2u;  x1 = x2 = x5;
rt5x3 = rt0x4 = round(r − 2u);
top4y4 = top0y1 = h;  bot1y2 = bot5y3 = 0,  y5 = 1/3h;
new aa, bb;                                    % auxiliaries for intersection of lines
rt5x6 = aa[rt5x1, rt5x3];  y6 = aa[y1, y3];
rt5x6 = bb[x5, x4];  y6 = bb[y5, y4];
w5 draw 6..3;                                                   % lower diagonal
lpen#;  w5 draw 4..5;                                             % erase excess
hpen;  w1 draw 1..2;                                                       % stem
w0 draw 4..5;                                                   % upper diagonal
if ucs ≠ 0:  call `a serif(1, 4, 2, −ucs);
    call `b serif(1, 4, 2, ucs);                              % upper stem serif
    call `c serif(2, 4, 1, −ucs);
    call `d serif(2, 4, 1, ucs);                              % lower stem serif
    call `e serif(4, 0, 5, −ucs);
    call `f serif(4, 0, 5, .5ucs);                        % upper diagonal serif
    call `g serif(3, 5, 1, −ucs);
    call `h serif(3, 5, 1, .5ucs);                        % lower diagonal serif
fi.

"The letter L";
call charbegin(`L, 12, 2sc, sc, ph, 0, 0);
hpen;  lft1x1 = round 2u;  x2 = x1;  top1y1 = h;  bot1y2 = 0;
w1 draw 1..2;                                                              % stem
if ucs ≠ 0.  call `a serif(1, 4, 2, −ucs);
    call `b serif(1, 4, 2, ucs);                              % upper stem serif
    call `c serif(2, 4, 1, −ucs);
    call `d serif(2, 4, 1, .5ucs);                            % lower stem serif
fi;
rt0x4 = round(r − 1.5u),  x3 = x4 + .5u,  y3 = y2,  y4 = y3 + 1.1aspect ucs u + eps,
call `e arm(2, 3, 4).                                       % arm and arm serif
```



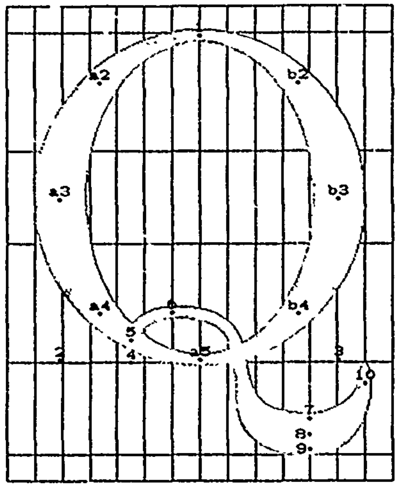


```
'The letter M",
call charbegin(`M, 16, 2sc, 2sc — 5mc rstem, ph, 0, hic rstem);
hpen,   lft_0x_1 = round 2u;   x_1 = x_2;   top_0y_1 = h,   bot_0y_2 = 0,
w_0 draw 1  2,                                                         % left stem
rt_1x_3 = round(r — 2u);   x_4 = x_1,   top_1y_3 = h,   bot_1y_4 = 0,
lft_1x_5 = lft_0x_1;   lft_0x_6 = lft_1x_3,   y_1 = y_5;   y_6 = y_3;
x_7 — x_5 = x_6 — x_8;   lft_1x_7 = lft_0x_8,   bot_1y_7 = 0,   y_8 = y_7,
w_1 draw 5  .7;                                                    % left diagonal
rpen#;   w_1 draw 8..6;                               % erase excess at lower rignt
hpen;   w_0 draw 8..6;                                            % right diagonal
w_1 draw 3..4;                                                        % right stem
if ucs ≠ 0:   call `a serif(2, 0, 1, —ucs),
      call `b serif(2, 0, 1, ucs);                               % lower left serif
      call `c serif(5, 4, 7, —ucs),                              % upper left serif
      call `d serif(3, 4, 4, ucs),                              % upper right serif
      call `e serif(4, 4, 3, —ucs);
      call `f serif(4, 4, 3, ucs);                              % lower right serif
fi.

"The letter N";
call charbegin(`N, 14, 2sc, 2sc — 5mc rstem, ph, 0, hic rstem),
hpen;   lft_0x_1 = round 2u;   x_1 = x_2;   top_0y_1 = h;   bot_0y_2 = 0;
w_0 draw 1  .2;                                                        % left stem
rt_0x_3 = round(r — 2u),   x_4 = x_3;   top_0y_4 = h,   bot_0y_3 = 0;
lft_5x_5 = lft_0x_1;   lft_5x_6 = lft_0x_1,   y_1 = y_5;   y_6 = y_3,
w_5 draw 5  .6;                                                         % diagonal
rpen#,   w_5 draw 4.  3;                              % erase excess at lower right
hpen;   w_0 draw 4..3,                                            % right diagonal
if ucs ≠ 0:   call `a serif(2, 0, 1, —ucs);
      call `b serif(2, 0, 1, ucs);                               % lower left serif
      call `c serif(5, 5, 6, —ucs);                              % upper left serif
      call `d serif(3, 0, 4, —ucs);
      call `e serif(3, 0, 4, ucs),                              % upper right serif
fi.
```

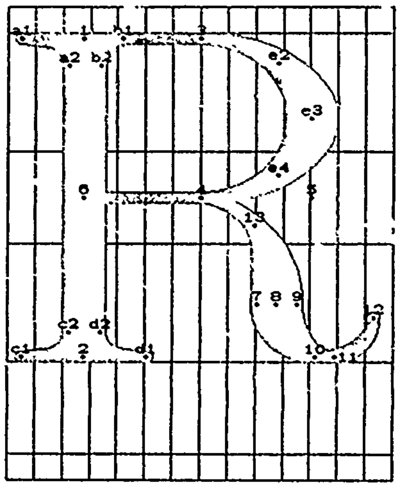




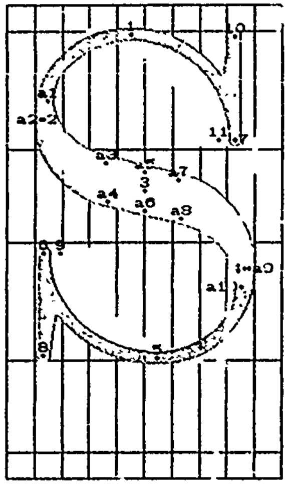
```
"The letter O";
call charbegin(`O. 14, mc·lbowl, --mc rbowl, ph, 0, mi[rbowl, 0]);
hpen;
if fixwidth ≠ 0:   new save;   save = sqrttwo;
      new sqrttwo;   sqrttwo = sqrt save;                      % super-superellipse
      lft5x2 == round 1.5u;
else.   lft5x2 == round u;
fi;
x1 = r -- x1;                                           % axis of left-right symmetry
top0y1 = h + oo;
bot0y2 == --oo;   y3 = y2;   x3 == r - x2;
call `a darc(1, 2, w5);                                          % left part of bowl
call `b darc(1, 3, w5);                                         % right part of bowl
if fixwidth ≠ 0:   new sqrttwo;   sqrttwo = save;
fi.

"The letter P";
call charbegin(`P, 12, 2sc, -mc(.75ph slant - 3pu), ph, 0, mi[.75ph·slant -- .5pu, 2.5pu]),
hpen,   lft1x1 = round 2u;   x2 == x1,   top4y1 = h;   bot1y2 == 0;
w1 draw 1..2;                                                                % stem
if ucs ≠ 0:
      call `a serif(1, 4, 2, -ucs);
      call `b serif(1, 4, 2, .5ucs);                                 % upper serif
      call `c serif(2, 4, 1, -ucs);
      call `d serif(2, 4, 1, ucs);                                   % lower serif
fi;
x3 = x4 = 7u;   rt5x5 = round(r -- u);   x6 = x1,
y3 = y1,   y6 = y4 = y5 = good0.5h;
w0 draw 1..3;                                                      % upper bar line
call `e darc(3, 5, w5);                                                     % bowl
w0 draw 4..6.                                                      % lower bar line
```



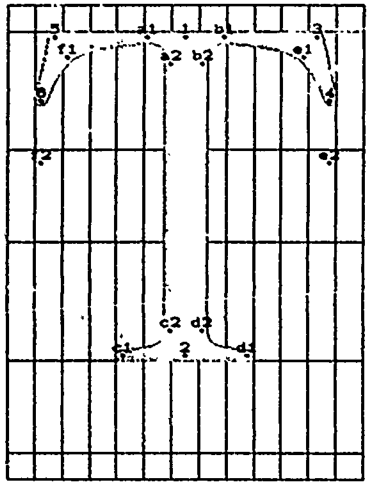
```
"The letter Q";
call charbegin(`Q, 14, mc·lbowl, —mc rbowl, ph, pdd, mi[rbowl, 0]);
hpen;
if fixwidth ≠ 0:   new save;   save = sqrttwo;
      new sqrttwo,   sqrttwo = sqrt save,                        % super-superellipse
      lft7x2 = round 1.5u;
else:   lft5x2 = round u;
fi;
x1 = r — x1;                                          % axis of left-right symmetry
top0y1 = h + oo;
bot0y2 = —oo;   y3 = y2;   x3 = r — x2;
call `a darc(1, 2, w5);                                         % left part of bowl
call `b dar    , 3, w5);                                        % right part of bowl
x1 = x5 = 4.5u;   y1 = 0;
new aa;   x5 = aa[x1, x2];   y5 = (sqrt(1 — aa·aa))[ 5y1 + .5y2, y2],
x6 = 6u;   y6 =  1h + 1.5w8;
w0 draw (4  .)5   6{1,0},                                       % left part of tail
vpen;   x7 = x8 = x9 = 11u;   bot8y8 = bot8y9 = —dd,   top6y7 = top8y8;
x10 = round 13u;   top8y10 = 0;
w8 ddraw 6{1,0}..7{1,0}, 6{1,0}.  9{1,0};                     % middle part of tail
w9 draw 8{1,0}..10{0,1};                                        % right part of tail
if fixwidth ≠ 0:   new sqrttwo;   sqrttwo = save,
fi.
```

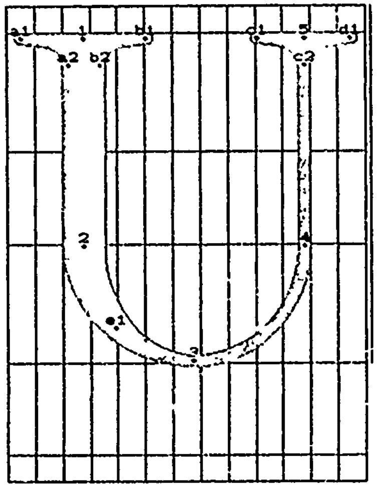


```
"The letter R";
hpen;
if ucs = 0:   call charbegin(`R, 12.5, 2sc, -mc(.75ph·slant - .75pu),
                          ph, 0, m[.75ph·slant - .75pu, 0]);
      rt x5 = round(r - .75u);
else:   call charbegin(`R, 14, 2sc, 0, ph, 0, .75ph·slant - 1.5pu);
      rt5x5 = round(r - 2u);
fi;
lft1x1 = round 2u;   x2 = x1;   top1y1 = h,   bot1y2 = 0;
w1 draw 1..2;                                                    % stem
if ucs ≠ 0:
      call `a serif(1, 4, 2, -ucs);
      call `b serif(1, 4, 2, .5ucs);                      % upper serif
      call `c serif(2, 4, 1, -ucs);
      call `d serif(2, 4, 1, ucs);                        % lower serif
fi;
x3 = x4 = 7u;   x6 = x4;
y3 = y1;   y4 = y6 = y5 = good0 .5h;
w0 draw 1..3;                                           % upper bar line
call `e darc(3, 5, w5);                                          % bowl
w0 draw 4..6;                                           % lower bar line
if ucs = 0:   rt1x7 = round(r - u);   bot1y7 = 0;
      w1 draw 4..7;                                  % diagonal stroke
else:   x8 = good5(x5 - 1.25u);   lft5x8 = lft0x7;   rt5x8 = rt0x9;
y7 = y8 = y9 = 1/3[y2, y1];
y13 = 5/6[y2, y1];   x13 = 1/sqrttwo[x1, x8];
draw |w0#|4{1, 0}..|.25[w0, w5]|13{x8 - x1, 2/3(y8 - y1)}..
      |w5#|8{0, -1};                                       % upper tail
y10 = y11 = y2;   y12 = .25[y2, y1];
x10 = .5[x7, x12],   x11 = .5[x9, x12];   rt0x12 = round(r - .5u);
w0 ddraw 7{0, -1}..10{1, 0}..12{0, 1},
      9{0, -1}..11{1, 0}..12{0, 1};               % lower tail and hook
fi.
```

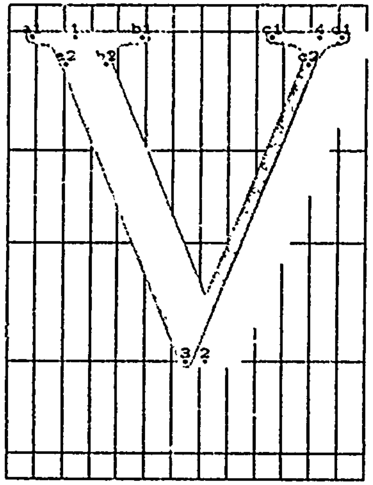


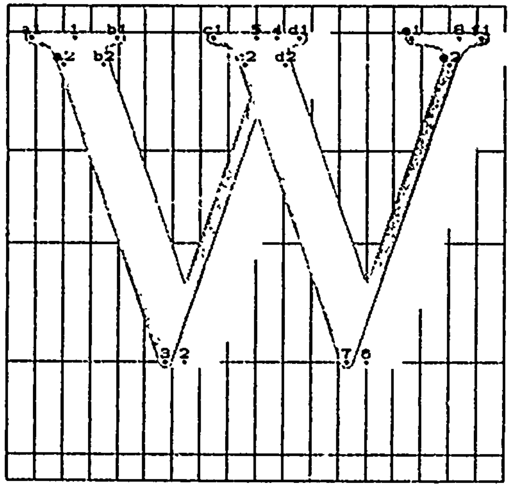
```
"The letter S";
call charbegin(`S, 10, 0, − 5mc(ph·slant − .5pu), ph, 0, hic(ph·slant − 5pu));
new w99;   w99 = round 2[w0, w1];
hpen;   top0y1 = h + oo;   bot0y5 = −oo;
x3 = .5r;   y3 = .52h;   lft99x2 = round u;   rt99x4 = round(r − u);
if ucs = 0·   x1 = x5 = x3;   x6 = x2;   x7 = x4;
     y6 = ⅓[top0 0, y3];   y7 = ⅓[bot0h, y3];
     w0 draw 6{x5 − x6, 3(y5 − y6)} .5{1, 0},                                % lower left stroke
     draw 7{x1 − x7, 2(y1 − y7)}  1{−1, 0};                                 % upper right stroke
else.   if w0 = w1:   x1 = x5 = x3;   x6 = x2;   x7 = x4,
          y6 = ⅓[top0 0, y3]:   y7 = ⅓[bot0h, y3];
          w0 draw 6{x5 − x6, 3(y5 − y6)} . . 5{1, 0};                         % lower left stroke
          draw 7{x1 − x7, 2(y1 − y7)}  . 1{−1, 0},                           % upper right stroke
          x8 = x9 = x6;   y9 = y6 + ucs·aspect u + eps,   bot0y8 = 0,
          x10 = x11 = x7;   y11 = y7 − ucs·aspect·u − eps,   top0y10 = h,
          w0 draw 8 . 9;                                                        % lower serif
          draw 10 . . 11;                                                       % upper serif
     else:   x1 = x3 − 5u;   x5 = x3 + 5u;   x6 = x2;   rt0x7 = round(r − 1.5u);
          y6 = good6 ⅓h − 1;   y7 = good0 ⅔h + 1;
          bot0y8 = 0;   y9 = y6;   x8 = x6,   rt1x6 = rt0x9,
          top0y10 = h;   y11 = y7;   x10 = x7,   lft1x7 = lft0x11,
          w0 ddraw 6 . 8, 9 . 8,                                               % lower serif
          ddraw 7 . 10, 11 . . 10;                                             % upper serif
          rpen#;   w1 draw 6{0, −1} . 5{1, 0};                                 % erase excess
          lpen#;   w1 draw 7{0, 1} . . 1{−1, 0};                                      % ditto
          hpen;   w0 draw 6{0, −1} . 5{1, 0};                                % lower left stroke
          draw 7{0, 1} . . 1{−1, 0};                                        % upper right stroke
     fi;
fi;
call `a sdraw(1, 2, 3, 4, 5, w99, round(pixels·pwv aspect + blacker),
                    −h/(50u)).                                                % middle stroke
```



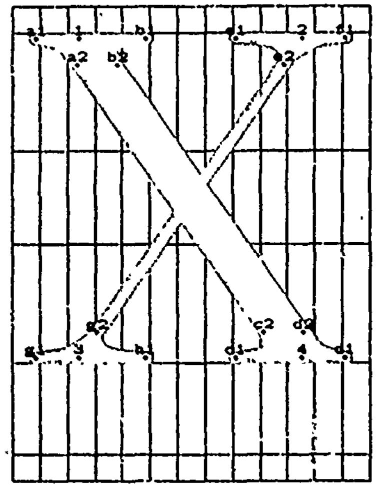


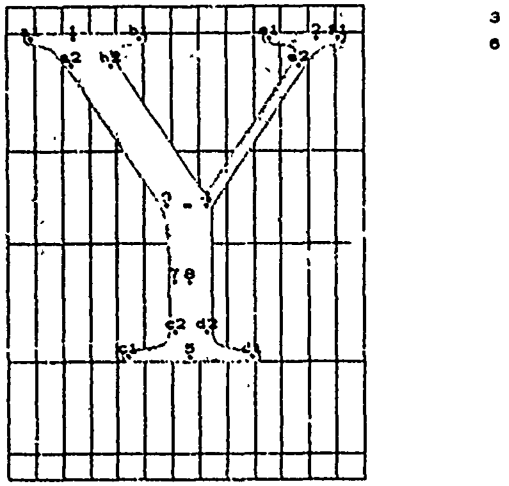
```
"The letter T";
call charbegin(`T, 13, sc + .75mc·ph·slant, sc — mc(armic — 2 5pu),
                    ph, 0, mi[armic, 2.5pv]);
hpen;   x1 = good.1 6 5u,   x2 = x1;
top1y1 = h;   bot1y2 = 0;
w1 draw 1..2;                                                    % stem
if ucs ≠ 0:   call `a serif(1, 4, 2, —.5ucs),
     call `b serif(1, 4, 2, .5ucs);                              % upper bracketing
     call `c serif(2, 4, 1, – ucs);
     call `d serif(2, 4, 1, ucs);                                % lower serif
fi,
new ss;   ss = 1.4aspect·ucs u + eps,
if ss + w0 > .25h:   new ss;   ss = .25h — w0 + eps;
fi;
rt0x3 = round(r — 1.5u);   x4 = x3 + 5u;   y3 = y1,   y4 = y3 — ss;
lft0x5 = round 1.5u;   x6 = x5 — .5u;   y5 = y1,   y6 = y5 – ss;
call `e arm(1, 3, 4);                                 % upper right arm and serif
call `f arm(1, 5, 6).                                  % upper left arm and serif

"The letter U";
call charbegin(`U, 13, 2sc(1 — mi) + mc(3ph slant + pu), 2sc ·   5mc rstem,
                    ph, 0, hic·rstem);
hpen;
if fixwidth ≠ 0    lft1x1 = round(1 5u),   rt0x5 = round(r — 1 5u);
else:   lft1x1 = round 2u,   rt0x5 = round(r — 2u);
fi;
x2 = x1;   x4 = x5,   x3 = .5[x2, x4];
top1y1 = h;   y5 = y1;   y2 = y4 = 36h,   bot0y3 = —oo;
if ucs ≠ 0:   call `a serif(1, 4, 2, —ucs);
     call `b serif(1, 4, 2, ucs);                                % left serif
     call `c serif(5, 0, 4, — ucs),
     call `d serif(5, 0, 4, ucs);                                % right serif
fi;
w4 draw 1..2;                                           % upper left stroke
call `e arc(3, 2, w1);                                  % lower left stroke
w0 draw 3{1, 0}..4{0, 1};                               % lower right stroke
draw 4..5.                                              % upper right stroke
```



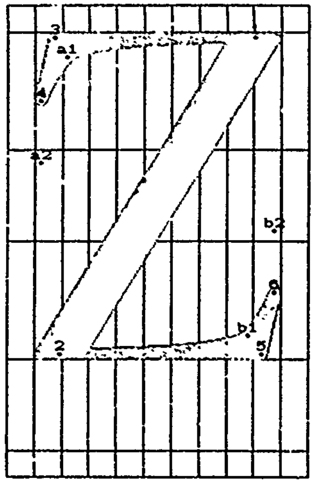


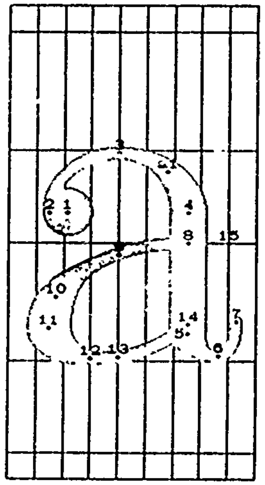
```
 "The letter V";
call charbegin(`V, 13, 2sc + mc(ph·slant + .5pu), 2sc − mc(rv − 2.5pu),
                    ph, 0, mi[rv, 2.5pu]);
hpen;   lft5x1 = round 1.5u,   rt0x4 = round(r − 1.5u),
x2 − x1 = x4 − x3,   lft0x3 = lft5x2;
top5y1 = h;   y4 = y1;   bot5y2 = −o,   y3 = y2,
w5 draw 1..2;                                          % left diagonal stroke
rpen#;   w5 draw 3..4;                             % erase excess at lower right
hpen;   w0 draw 3..4;                                 % right diagonal stroke
if ucs ≠ 0:   call `a serif(1, 5, 2, −.5ucs);
     call `b serif(1, 5, 2, ucs),                                  % left serif
     call `c serif(4, 0, 3, −ucs);
     call `d serif(4, 0, 3, .5ucs);                              % right serif
fi.

"The letter W";
call charbegin(`W, 18, 2sc + mc(ph·slant + .5pu), 2sc − mc(rv − 2.5pu),
                    ph, 0, mi[rv, 2.5pu]);
hpen;   lft5x1 = round 1.5u;
rt0x9 = rt5x10;   x11 − x10 = x9 − x1,   rt0x11 = r − 1.5u,
% x9, x10, and x11 are approximations to x4, x5, and x8
x5 − x1 = x6 − x2 = x7 − x3 = x8 − x4 = round(x10 − x1),
% The idea is to draw two V's displaced by an integer amount.
top5y1 = h;   bot5y2 = −o;   y1 = y4 = y5 = y2;   y1 = y5 = y8 = y4;
rt0x4 = rt5x5,   lft0x3 = lft5x2;   x2 − x1 = x4 − x3;
w5 draw 1..2;                                              % first diagonal
rpen#;   w5 draw 3..4,                                         % erase excess
hpen;   w0 draw 3..4;                                      % second diagonal
w5 draw 5..6;                                               % third diagonal
rpen#;   w5 draw 7..8;                                         % erase excess
hpen,   w0 draw 7..8;                                      % fourth diagonal
if ucs ≠ 0:   call `a serif(1, 5, 2, −.5ucs);
     if w0 = w5   call `b serif(1, 5, 2, ucs),
     else:   call `b serif(1, 5, 2, .5ucs),
     fi;                                                           % left serif
     call `c serif(5, 5, 6, −.5ucs);
     call `d serif(5, 5, 6, .5ucs);                             % middle serif
     call `e serif(8, 0, 7, −ucs),
     call `f serif(8, 0, 7, .5ucs),                              % right serif
fi.
```





```
"The letter X";
call charbegin('X, 13, 2sc, 2sc -- .5mc rv, ph, 0, hc·rv);
hpen;   lft5x1 = round 1 5u;   rt5x1 = round(r — 1 5u);   x1 = x1;   x1 = x2;
top5y1 = h;   bot5y1 = 0;   y2 = y1;   y1 = y1;
w5 draw 1..4;                                      % upper left to lower right diagonal
w0 draw 3..2;                                      % lower left to upper right diagonal
if ucs ≠ 0:   call 'a serif(1, 5, 4, --.5ucs);
     call 'b serif(1, 5, 4, ucs);                                     % upper left serif
     call 'c serif(4, 5, 1, — ucs);
     call 'd serif(4, 5, 1, .5ucs);                                   % lower right serif
     new ss;   ss = .5(w5 — w0)/u;                     % correction to ucs makes w0 like w5
     call 'e serif(2, 0, 3, --ucs -- ss);
     call 'f serif(2, 0, 3, 5ucs + ss),                               % upper right serif
     call 'g serif(3, 0, 2, -  5ucs -  ss),
     call 'h serif(3, 0, 2, ucs + ss),                                 % lower left serif
fi.

"The letter Y";
call charbegin('Y, 13, 2sc + mc(ph slant + 5pu), 2sc - mc(rv - 2 5pu),
                    ph, 0, mi[rv, 2 5pu]);
hpen;   lft5x1 = round 1 5u,   rt0x2 = round(r -- 1 5u),
top5y1 = top0y2 = h,
rt5x1.1 = rt0x1.1;   x1.1 — x1 = x2 — x1.1,                  % approximations before rounding
x3 = good5x1.1;   rt5x3 = rt1x6 = rt0x4,   lft0x9 = lft5x3;
y3 = y4 = y6 = y9 = .48h,   y7 = y8 = 5[y5, y6],   bot1y5 = 0,
x5 = x6 = x8;   lft0x7 = lft1x8;
w5 draw 1 .3;                                                          % left diagonal
minvr 0;   minvs 0;
w0 ddraw 9{x1 — x1, y1 — y1} .7{0, -1}, 6  8;                               % transition
minvr .5;   minvs .5;
w1 draw 6..5;                                                                    % stem
w0 draw 4..2;                                                          % right diagonal
if ucs ≠ 0:   call 'a serif(1, 5, 3, — 5ucs);
     call 'b serif(1, 5, 3, ucs);                                     % upper left serif
     call 'c serif(5, 4, 6, — ucs);
     call 'd serif(5, 4, 6, ucs),                                         % lower serif
     call 'e serif(2, 0 4, - ucs);
     call 'f serif(2, 0, 4, 5ucs),                                    % upper right serif
fi.
```

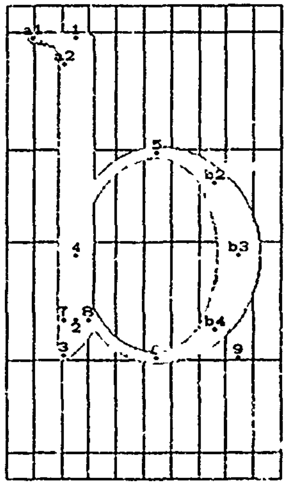


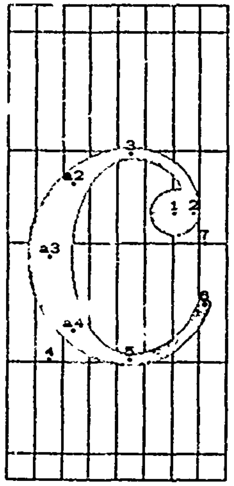


```
"The letter Z";
call charbegin(`Z, 11, 0, — 5mc(ph slant — 5pu), ph, 0, l ic(ph slant — 5pu)),
hpen;   lft_5 x_2 = round u;   rt_5 x_1 = round(r — u`;
top_5 y_1 = h,   bot_5 y_2 = 0;
new ss;   ss = 1.4aspect ucs u + eps,
if ss + w_5 > 25h   new ss,   ss = 25h — w_6 + eps,
fi;
lft_0 x_4 = round 1 5u;   x_3 = x_1 — 5u;   y_3 = y_1;   y_4 = y_1 — ss;
rt_0 x_5 = round(r — 1.5u);   x_6 = x_5 + 5u,   y_5 = y_2,   y_6 = y_5 + ss,
call `a arm(1, 3, 4);                                              % upper arm and serif
w_5 draw 1   2;                                                    % diagonal
call `b arm(2, 5, 6).                                              % lower arm and serif
```

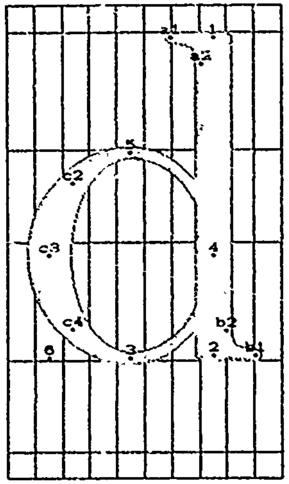
The file roman1 mf

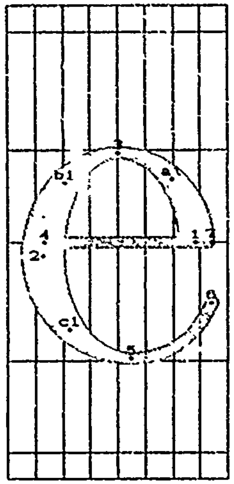
```
% This lower-case roman alphabet was prepared by D E Knuth in November, 1979,
% inspired by the Monotype alphabet used in The Art of Computer Programming
% Its spacing is intended for text only.
% Character codes '141-'172 are generated

"The letter a",
call charbegin(`a, 9, 0, sc, px, 0, ½[pc, px]·slant + 5pwi + (sc — 2)pu),
cpen;   lft_3 x_1 = round 1.25u,
if top_1(top_3 top_6 c + 2) > .9[c, m]   top_1 y_1 = 9[c, m];
else    y_1 = top_1 top_6 c + 2;
fi,
w_1 draw 1;                                                        % bulb
hpen;   lft_0 x_2 = lft_1 x_1;   y_2 = y_1,   x_4 = 4u,   top_0 y_3 = m + oo,
x_1 = x_5 = good_1(r — 2 5u);   y_4 = ½[c, m];
w_0 draw 2{0, 1}   3{1, 0};   call `a arc(3, 4, w_1),              % shoulder
if lcs = 0:   bot_1 y_5 = 0,   w_1 draw 4 .5,                      % stem
else:   y_5 = 2[top_1 0, c],   rt_0 x_6 = 5[rt_1 x_5, rt_0 x_7];
      bot_0 y_6 = 0;   rt_0 x_7 = round(r — 5u);   y_7 = c/3,
      w_1 draw 4. 5,                                               % stem
      draw |w_1#|5{0, — 1}   |w_0#|6{1, 0}   7{0, 1}.              % hook
fi;
x_8 = x_1;   y_8 = c;   x_9 = 4u,   y_9 = 9[w_0, y_8],   x_10 = x_11 + .25u,   y_10 = 5[w_0, y_8],
x_11 = good_1 1 5u,   y_11 = 2[w_0, y_8],
x_12 = 3u;   bot_0 y_12 = - oo,   x_14   4u,   y_14 = 015[y_12, y_8],
x_13 = x_8,   y_13 = 3[y_12, y_8],   x_15 = r — u,   y_15 = c,
draw |w_0|8{—1, 0}  .|w_0#|9   |.8[w_0, w_2]|10   |w_2#|11{0, —1}
     |.7[w_0, w_2]|12{1, 0}   |w_0#|13   14(   15).                 % bowl
```

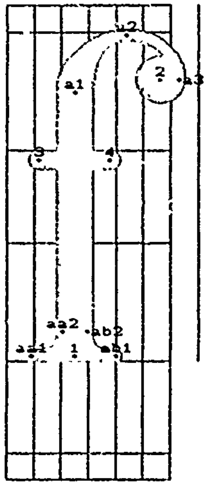




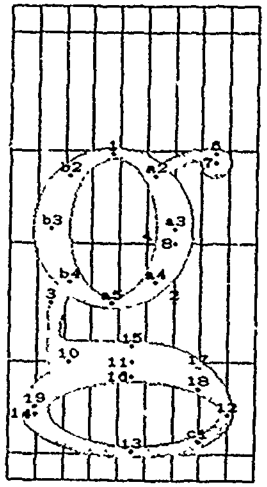
```
"The letter b";
call charbegin(`b, 10, sc, 0, ph, 0, 5px slant + lcic),
hpen,   x1 = x2 = x4 = good1 2 5u;   top1y1 = h;
lft0x7 = lft1x1;   x3 = x7;   x5 = x6 = 5(r + u),   rt0x8 = rt1x2;
bot0y3 = 0;   y4 = 5[y5, y6],   top0y5 = m + oo;   bot0y6 = -oo,
new aa;   rt1x2 = aa[x6, x4];
y2 = y7 = y8 = (sqrt(1 - aa·aa))[y4, y6];                    % where bowl meets stem
if lcs ≠ 0.   call `a serif(1, 1, 2, -lcs);                          % upper serif
fi;
w1 draw 1..2;                                                                % stem
w0 ddraw 7  3, 8{0, -1}  3{x4 - x8, 5(y4 - y8)},                              % spur
w0 draw 6{-1, 0}  4{0, 1}  .5{1, 0},                             % left part of bowl
if w2 > 1.5u   rt2x9 = round(r - .75u),
     else:   x9 = good2(r - 1 5u),
fi;
y9 = y4,   call `b darc(5, 9, w2)                                % right part of bowl

"The letter c";
call charbegin(`c, 8, 0, 0, px, 0, px slant - pu),
cpen;   rt3x1 = round(r - u),
if top1(top1top0c + 2) > .9[e, m]   top1y1 = 9[e, m],
else:   y1 = top1top0c + 2;
fi;
w3 draw 1;                                                                   % bulb
hpen;   rt0x2 = rt1x1;   y2 = y1;   x3 = x5 = 5(r + u),   top0y3 = m + oo,
w0 draw 2{0, 1}..3{-1, 0};                                               % shoulder
if w2 > 1.5u   lft2x4 = round(.75u);
else   x4 = good2 1.5u;
fi;
y4 = y5;   bot0y5 = -oo,
call `a darc(3, 4, w2);                                                     % stroke
if w0 = w1   x6 = x2;   x7 - x5 = x5 - x4,   y7 = 5[y3, y5],
     new aa;   x6 = aa[x5, x7],   y6 = (sqrt(1 - aa·aa))[y7, y5],
else:   lft0x6 = rt0x2;   y6 = .5e - 1,   x7 = x6,   y7 = e,
fi;
w0 draw 5{1, 0}..6(   7).                                                        % point
```

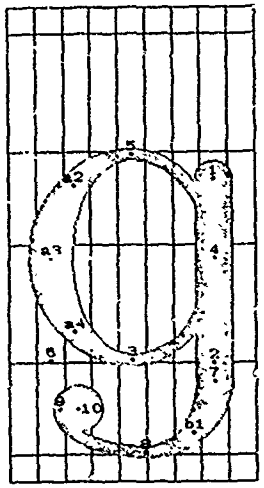




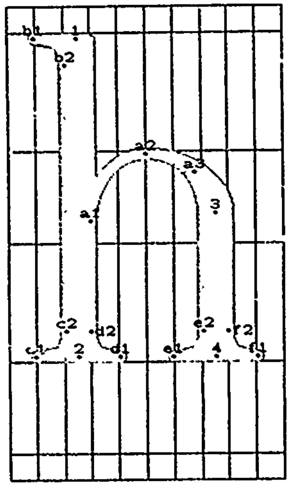


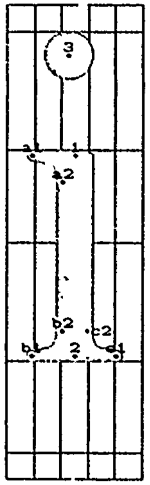
```
"The letter d",
call charbegin(`d, 10, 0, sc, ph, 0, ph slant + 5pwi + (sc − 2)pu),
hpen;   x1 = x2 = good1(r − 2 5u),   top1y1 = h,   bot1y2 = 0;
w1 draw 1 . 2,                                                         % stem
if lcs ≠ 0:   call `a serif(1, 1, 2, −lcs);                      % upper serif
     call `b serif(2, 1, 1, lcs);                                % lower serif
fi;
bot0y3 = −oo;   top0y5 = m + oo,   y4 = 5[y3, y5],
x3 = x5 = .5(r − u);   x4 = x2,
w0 draw 3{1, 0} . 4{0, 1} . 5{−1, 0};                     % right part of bowl
if w2 > 1 5u   lft2x6 = round 75u;
else   x6 = good2 1.5u,
fi;
y6 = y3,   call `c darc(5, 6, w2)                           % left part of bowl

"The letter e";
call charbegin(`e, 8, 0, 0, px, 0, pe slant + lcic + 25pu);
hpen;   x1 = 5r,   top0y3 = m + oo,   y1 = e,   y2 = 5[y3, y1],
if w2 > 1 5u   lft2x2 = round 5u,   rt1x1 = round(r − 5u);
else:   x2 = good2 1.25u,   x1 = good1(r − 1 25u),
fi;
bot0y5 = −oo,   x5 = x1 + 5u,
call `a arc(3, 1, w1);                                                  % bowl
call `b arc(3, 2, w2),   call `c arc(5, 2, w2);                       % stroke
new aa;   y4 = y1 = aa[y2, y3];   x4 − 1 = (sqrt(1 − aa aa))[x3, x2];
w0 draw 4 . . 1;                                                        % bar
if w0 = w1:   x6 = x1;   x7 − x5 = x1   x3;   y7 = y1,
     new aa:   x6 = aa[x5, x7];   y6 = (sqrt(1 − aa aa))[y7, y5],
else.   rt0x6 = rt2x1;   x7 = x6,   y6 = 5e − 1,   y7 = −e,
fi,
w0 draw 5{1, 0} . 6(. . 7).                                           % point

"The letter f",
call charbegin(`f, 6, 0, 0, ph, 0, ph slant + pu),
hpen;   x1 = good1 2.5u,
if fixwidth = 0·   rt1x2 = round(r + 5u);
else   rt1x2 = round(r − u),
fi,
cpen,   top1y2 = 8[m, h],
call `a fstroke(2, 1);                     % bulb, shoulder, stem, and serif
cpen;   top10y3 = m,   y4 = y3,   lft10x3 = lft1x1 − u − eps,   rt10x4   rt1x1 + u + eps,
w10 draw 3 . 4                                                          % bar
```

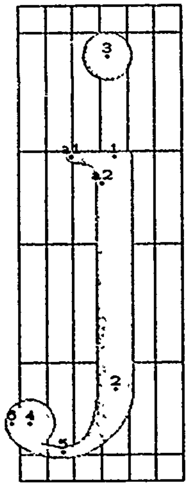




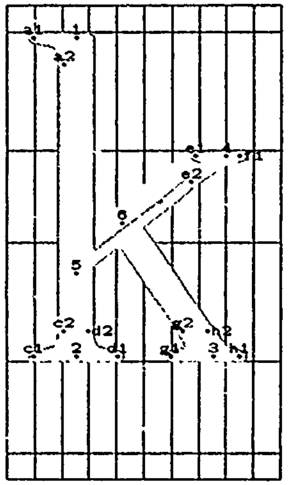
```
"The letter g";
if varg = 0:                                  % the following program is for a 'classic' g shape
    call charbegin(`g, 9, 0, 0, px, pd, px·slant + .5pwi1 − pu);
    hpen;   x3 = good1 1.5u;   x2 = good1 4r;   x1 − x3 = x2 − x1;
    top0y1 = m + oo;   y2 = y3 = round .5e;
    call `a darc(1, 2, w1);   call `b darc(1, 3, w1);                        % bowl
    x4 = x2 − u;   y4 = e;
    x5 = 1/sqrttwo[x1, x2];   y5 = 1/sqrttwo[.5y1 + .5y2, y1];
    x6 = x7 = r − 1.5u;
    new w90;   w90 = round .5[w0, w1];
    cpen;   top6y6 = top90y7 = m + oo;
    w90 draw 7;   w0 draw (4 .. )5 .. 6{1, 0};                               % ear
    vpen;   x8 = x2;   y8 = e;
    x9 = 1/sqrttwo[x1, x3];   y9 = 1/sqrttwo[.5y1 + .5y3, y3];
    x10 = x9;   y10 = y11 = good8 0;   x11 = x13 = .5r;   x12 = good0(r − u);
    y12 = .5[bot8y11, top6y13];   bot6y13 = −d − oo;
    draw (8 .. )|w0|9 .. |w8#|10{1, 0} .. 11{1, 0};                           % left part of link
    top8y15 = top6y13;   x15 = x16 = x11;   bot8y16 = bot6y16;
    x17 = 1/sqrttwo[x15, x12];   y17 = 1/sqrttwo[y12, y15];
    x18 = 1/sqrttwo[x16, x12];   y18 = 1/sqrttwo[y12, y16];
    hpen;   w0 ddraw 15{1, 0} .. 17{x12 − x15, y12 − y15} .. 12{0, −1},
        16{1, 0} .. 18{x12 − x16, y12 − y16} .. 12{0, −1};                   % right part of link
    call `c arc(13, 12, w0);                                                  % right part of tail
    new w90;   w90 = round .5[w0, w1];
    x14 = x19 = good90u;   y14 = .5[y13, y16];   y19 = .5[y11, y11];
    w90 ddraw 13{−1, 0} .. 14{0, 1} .. 16{1, 0},
        13{−1, 0} .. 19{0, 1} .. 11{1, 0};                                    % left part of tail
else:                                         % the following program is for a 'simple' g shape
    call charbegin(`g, 9, 0, 0, px, pd, .9px·slant + .5pwi − pu);
    hpen;   x1 = x2 = good1(r − 1.5u);   x4 = x1;   x3 = x5 = .5r;
    bot0y3 = −oo;   top0y5 = m + oo;   y4 = .5[y3, y5];
    w1 draw 3{1, 0} .. 4{0, 1} .. 5{−1, 0};                                   % right part of bowl
    if w2 > 1.5u:   lft2x6 = round .75u;
    else:   x6 = good2 1.5u;
    fi;
    y6 = y4;   call `a darc(5, 6, w2);                                        % left part of bowl
    cpen;   top1y1 = .5[e, m];   y2 = e;   w1 draw 1 .. 2;                    % stem
    hpen;   x7 = x2;   bot1y7 = −.25d;   w1 draw 2 .. 7;                      % link
    x10 = good3 2.5u;   x8 = .5[x10, x7];   lft0x9 = lft3x10;
    y9 = y10;   bot0y8 = −d − oo;
    cpen;   bot3y10 = −.75d;   w3 draw 10;                                    % bulb
    hpen;   w0 draw 9{0, −1} .. 8{1, 0};   call `b arc(8, 7, w1);             % tail
fi.
```

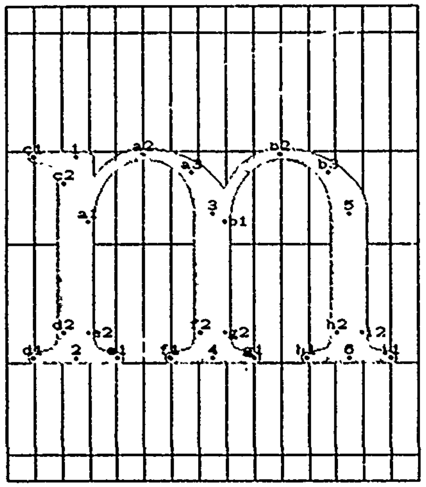


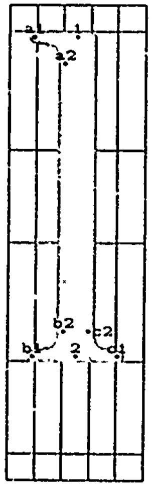




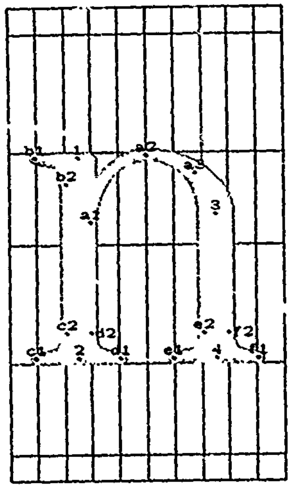
```
'The letter h";
call charbegin(`h, 10, sc, sc, ph, 0, ½[pc, px] slant + .5pwι + (sc − 2)pu),
hpen;   x_1 = x_2 = good_1 2.5u;   x_3 = good_1(r − 2.5u),
top_1 y_1 = h;   bot_1 y_2 = 0;
w_1 draw 1 . 2,                                                   % left stem
call `a hstroke(2, 3, 4);                            % shoulder and right stem
if lcs ≠ 0:   call `b serif(1, 1, 2, −lcs);                     % upper serif
     call `c serif(2, 1, 1, −lcs);
     call `d serif(2, 1, 1, lcs);                          % lower left serif
     call `e serif(4, 1, 3, −lcs);
     call `f serif(4, 1, 3, lcs);                         % lower right serif
fi

"The letter ı";
call charbegin(`ı, 5, sc, sc, ph 0, ph slant + 5pwι + (sc − 2)pu),
hpen;   x_1 = x_2 = good_1 .5r,   top_1 y_1 = m,   bot_1 y_2 = 0;
w_1 draw 1   2,                                                       % stem
cpen;   top_3 y_3 = h;   rt_3 x_3 = rt_1 x_1,   w_3 draw 3;              % dot
if lcs ≠ 0:   call `a serif(1, 1, 2, −lcs),                     % upper serif
     call `b serif(2, 1, 1, −lcs),
     call `c serif(2, 1, 1, lcs),                               % lower serif
fi.

"The letter ȷ";
call charbegin(`ȷ, 6, sc, 0, ph, pd, ph·slant + 5pwι − 2pu)
hpen,   x_1 = x_2 = good_1(r − 2 5u);
if fixwidth = 0    lft_3 x_1 = round(− 5u);
else    lft_3 x_1 = round u;
fi;
cpen;   top_3 y_3 = h,   rt_3 x_3 = rt_1 x_1;   w_3 draw 3;             % dot
bot_3 y_4 = −.9d;   w_3 draw 4;                                       % bulb
hpen,   top_1 y_1 = m;   bot_1 y_2 = −½d,
bot_0 y_5 = −d − oo,   y_4 = y_6,   lft_0 x_6 = lft_3 x_4,   x_5 = .5[x_2, x_6];
draw |w_1|1   |w_1#|2{0, −1}   |w_0#|5{−1, 0} . 6{0, 1};       % stem and tail
if lcs ≠ 0:   call `a serif(1, 1, 2, −lcs),                           % serif
fi.
```

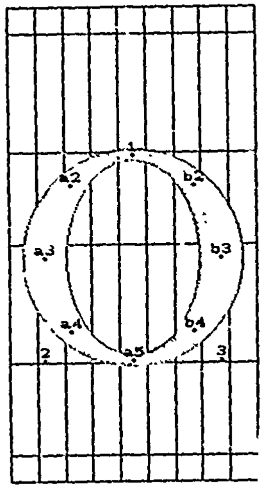


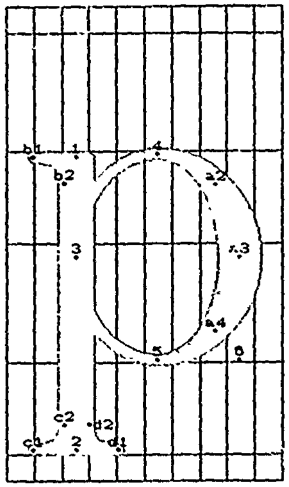




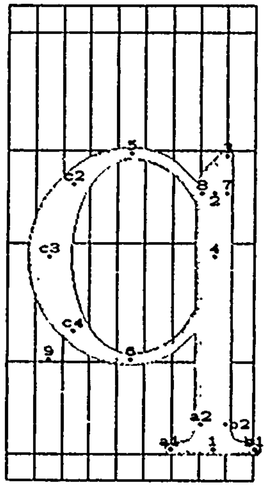
```
"The ietter k";
call charbegin(`k, 10, sc, sc, ph, 0, px slant + 5pwi + (lcss + sc - 2)pu);
hpen,   x1 = x2 = x5 = good1 2 5u,
x3 = good1(r - 2 5u);   rt1x3 = rt0x1,
top1y1 = h;   top0y1 = m,   bot1y2 = bot1y3 = 0;   y5 = .75e,
new aa, bb;                                        % auxiliaries for intersection of lines
rt1x6 = aa[rt1x1, rt1x5];   y6 = aa[bot0m, y1];
rt1x6 = bb[x5, x1];   y6 = bb[y5, y1],
w1 draw 6   3;                                                         % lower diagonal
!pen#,   w1 draw 4  .5,                                                  % erase excess
hpen,   w1 draw 1  .2;                                                           % stem
w0 draw 4  .5;                                                         % upper diagonal
if lcs ≠ 0:   call `a serif(1, 1, 2, -lcs);                             % upper stem serif
     call `c serif(2, 1, 1, -lcs);
     call `d serif(2, 1, 1, lcs);                                       % lower stem serif
     call `e serif(4, 0, 5, -lcs),
     call `f serif(4, 0, 5, lcss);                                  % upper diagonal serif
     call `g serif(3, 1, 6, -lcs),
     call `h serif(3, 1, 6, lcss);                                  % lower diagonal serif
fi.

"The letter l";
call charbegin(`l, 5, sc, sc, ph, 0, ph·slant + 5pwi + (sc - 2)pu),
hpen;   x1 = x2 = good1 5r;   top1y1 = h,   bot1y2 = 0,
w1 draw 1 . 2,                                                                   % stem
if lcs ≠ 0.   call `a serif(1, 1, 2, -lcs),                               % upper serif
     call `b serif(2, 1, 1, -lcs);
     call `c serif(2, 1. 1, lcs);                                           % lower serif
fi.

"The letter m";
call charbegin(`m, 15, sc, sc, px, 0, ½[pe, px] slant + 5pwi + (sc - 2)pu),
hpen,   x1 = x2 = good1 2 5u,   x3 = good1 5r,   x5 - x3 = x3 - x1,
top1y1 = m,   bot1y2 = 0;
w1 draw 1 . 2;                                                              % left stem
call `a hstroke(2, 3, 4);                               % left shoulder and middle stem
call `b hstroke(4, 5, 6),                                % right shoulder and right stem
if lcs ≠ 0·   call `c serif(1. 1, 2, --lcs);                              % upper serif
     call `d serif(2, 1, 1  -lcs),
     call `e serif(2, 1. 1, lcs);                                      % lower left serif
     call `f serif(4, 1, 3, --lcs),
     call `g serif(4, 1, 3, lcs),                                    % lower middle serif
     call `h serif(6, 1, 5, -lcs),
     call `i serif(6, 1, 5, lcs);                                     % lower right serif
fi.
```

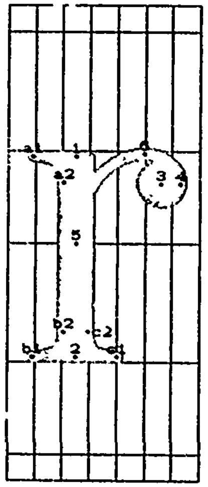




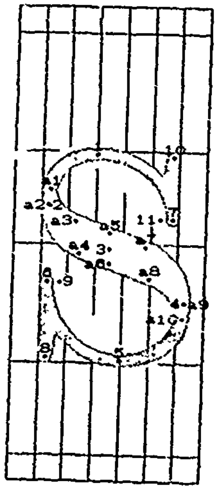


```
"The letter n";
call charbegin(`n, 10, sc, sc, px, 0, ½[pe, px] slant + 5pwi + (sc - 2)pu),
hpen,   x1 = x2 = good1 2.5u,   x3 = good1(r - 2.5u);
top1y1 = m;   bot1y2 = 0;
w1 draw 1 . 2;                                              % left stem
call `a hstroke(2, 3, 4);                      % shoulder and right stem
if lcs ≠ 0:   call `b serif(1, 1, 2, -lcs);                % upper serif
     call `c serif(2, 1, 1, -lcs),
     call `d serif(2, 1, 1, lcs);                      % lower left serif
     call `e serif(4, 1, 3, -lcs);
     call `f serif(4, 1, 3, lcs);                     % lower right serif
fi.

"The letter o";
call charbegin(`o, 9, 0, 0, px, 0, 5px slant),
hpen;   x1 = r - x1;                        % axis of left-right symmetry
lft2x2 = round fixwidth[5u, 1 5u],
x1 - x2 = x3 - x1,   top0y1 = m + oo,   bot0y2 = -oo,   y2 = y1,
call `a darc(1, 2, w2);                              % left part of bowl
call `b darc(1, 3, w2).                             % right part of bowl

"The letter p";
call charbegin(`p, 10, sc, 0, px, pd, 5px slant + lcic);
hpen,   x1 = x2 = x3 = good1 2 5u,   x4 = x5 = 5(r + u),
if w2 > 1.5u:   rt2x6 = round(r - 75u),
else    x6 = good2(r - 1 5u),
fi,
top1y1 = m;   bot1y2 = -d;   top0y4 = m + oo,   bot0y5 = -oo,
y3 = 5[y1, y5],   y6 = y5;                                    % stem
w1 draw 1 . . 2;                                     % left part of bowl
w0 draw 5{-1, 0} . . 3{0, 1}   4{1, 0},             % right part of bowl
call `a darc(4, 6, w2);                                   % upper serif
if lcs ≠ 0:   call `b serif(1, 1, 2, -lcs),
     call `c serif(2, 1, 1, -lcs),                        % lower serif
     call `d serif(2, 1, 1, lcs);
fi
```

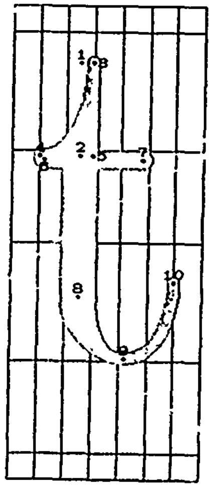


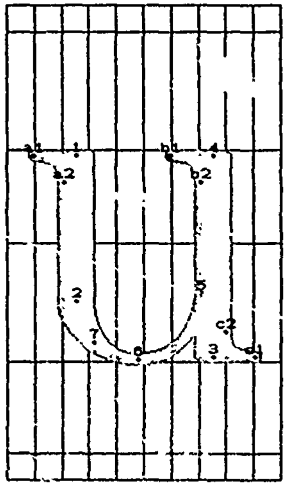


```
`The letter q";
call charbegin(`q, 10, 0, 1, px, pd, px slant + .5pwı − pu);
hpen;  x_1 = good_1(r − 2 5u);  x_5 = 5(r − u);  x_2 = x_4 = x_1,  bot_1 y_1 = −d;
rt_0 x_7 = rt_1 x_1;  x_3 = x_7;  x_5 = x_6;  lft_0 x_8 = lft_1 x_2;
top_0 y_3 = m;  y_4 = .5[y_5, y_6];  top_0 y_5 = m + oo;  bot_0 y_6 = −oo;
new aa;  lft_1 x_2 = aa[x_6, x_1];
y_2 = y_7 = y_8 = (sqrt(1 − aa·aa))[y_4, y_5],                % where bowl meets stem
if lcs ≠ 0:  call `a serif(1, 1, 2, −lcs);
     call `b serif(1, 1, 2, lcs);                                   % lower serif
fi;
w_1 draw 1..2;                                                       % stem
w_0 ddraw 7..3, 8{0, 1}..3{x_3 − x_8, 5(y_3 − y_8)};                 % spur
w_0 draw 6{1, 0}. 4{0, 1}..5{−1, 0};                        % right part of bowl
if w_2 > 1.5u:  lft_2 x_9 = round 75u;
else   x_9 = good_2 1 5u,
fi;
y_9 = y_6;  call `c darc(5, 9, w_2)                          % left part of bowl

"The letter r";
call charbegin(`r, 7, sc, 0, px, 0, px slant);
hpen,  x_1 = x_2 = good_1 2 5u,  top_1 y_1 = m;  bot_1 y_2 = 0,
w_1 draw 1. 2;                                                       % stem
cpen;  rt_3 x_3 = rt_0 x_1 = round(r − .5u);  top_3 y_3 = .9[e, m];  y_4 = y_3,
w_3 draw 3;                                                          % bulb
hpen;  x_5 = x_1;  y_5 = e;  x_6 = 5u;  top_0 y_6 = m + oo;
w_0 draw 5{0, 1}..6{1, 0} .4{0, −1};                             % shoulder
if lcs ≠ 0.  call `a serif(1, 1, 2, −lcs);                    % upper serif
     call `b serif(2, 1, 1, −lcs);
     call `c serif(2, 1, 1, lcs);                                   % lower serif
fi.
```

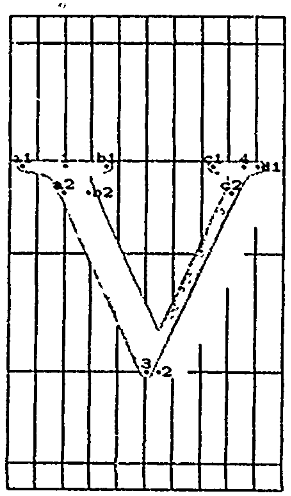


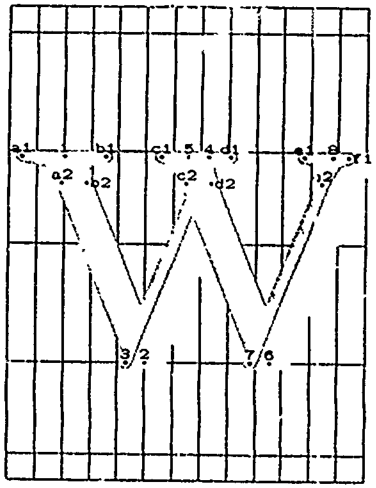
```
"The letter s",
call charbegin('s, 7, 0, 0, px, 0, px slant − .5pu);
hpen;   top0y1 = m + oo;   bot0y5 = −oo;
x3 = .5r,   (y3 − w6 − .5w8)/(m − 2w6 − w8) = e/m;                % white space ratio
lft11x2 = round u;
if lcs = 0:   x1 = x5 = x3;   lft0x6 = round .75u,   x7 = x1;   rt11x4 = round(r − u),
    y6 = 1/3[top0 0, y5],   y7 = 1/4[bot0 m, y1],
    w0 draw 6{x5 − x6, 3(y5 − y6)} .. 5{1, 0},                      % lower left stroke
    draw 7{x1 − x7, 2(y1 − y7)} .. 1{−1, 0};                        % upper right stroke
else:   if w0 = w1:   x1 = x5 = x3;   x6 = x2;   x7 = x4;   rt11x4 = round(r − u);
        y6 = 1/3[top0 0, y5];   y7 = 1/4[bot0 m, y1];
        w0 draw 6{x5 − x6, 3(y5 − y6)} .. 5{1, 0};                  % lower left stroke
        draw 7{x1 − x7, 2(y1 − y7)} .. 1{−1, 0},                    % upper right stroke
        x8 = x9 = x6;   y9 = y6 + lcs·aspect·u + eps,   bot0y8 = 0,
        x10 = x11 = x7;   y11 = y7 − lcs·aspect·u − eps,   top0y10 = m,
        w0 draw 8 .. 9;                                                       % lower serif
        draw 10 .. 11;                                                         % upper serif
    else:   x1 = x3 − .5u;   x5 = x1 + .5u;   x6 = x2,   rt0x7 = round(r − u),   rt11x4 =
round(r − .5u);
        y6 = good6(2/7 y1) − 1,   y7 = good6(5/7[y5, m]) + 1,
        bot0y8 = 0;   y9 = y6,   x8 = x6,   rt1x6 = rt0x9,
        top0y10 = m,   y11 = y7:   x10 = x7,   lft1x7 = lft0x11,
        w0 ddraw 6 .. 8, 9 .. 8;                                              % lower serif
        ddraw 7 .. 10, 11 .. 10;                                              % upper serif
        rpen#;   w1 draw 6{0, −1} .. 5{1, 0};                                 % erase excess
        lpen#;   w1 draw 7{0, 1} .. 1{−1, 0};                                      % ditto
        hpen;   w0 draw 6{0, −1} .. 5{1, 0},                             % lower left stroke
        draw 7{0, 1} .. 1{−1, 0},                                       % upper right stroke
    fi,
fi;
new aa;
if m − e > e:   aa = m − e,
else:   aa = e,
fi,
call 'a sdraw(1, 2, 3, 4, 5, w11, w8, −aa/(12u)).                       % middle stroke
```



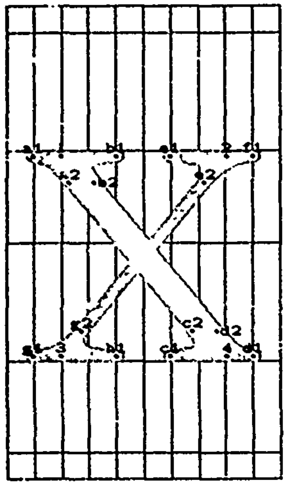


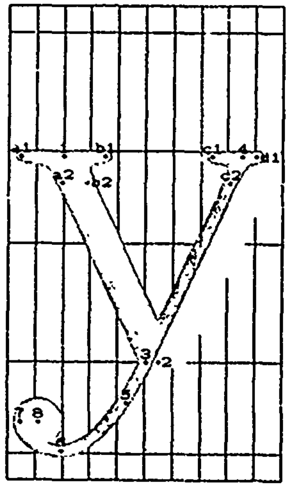
```
"The letter t";
if px - pe < .75(ph - px):   call charbegin(`t, 7, J, 0, 2px - pe, 0, px·slant + .5pwi - 2pu);
      y1 = 2m - e;
else·  call charbegin(`t, 7, 0, 0, .75[px, ph], 0, p· slant + 5pwi - 2pu);
      y1 =  75[m, h];
fi;
hpen,   x1 = x2 = good1 2 5u;   top0y2 = m;
if w0 = w1:   w1 draw 1..2;                                          % upper terminal
else:  rt1x1 = rt0x3;   lft0x1 = lft1x1 - u - eps;   y1 = y5 = y2,   y3 = y1;   x5 = x3;
      w0 ddraw 4{1, 0}..3{0, 1}, 4..5;                            % left and ·pper terminals
fi;
lft10x6 = lft1x1 - u - eps,   rt10x7 = rt1x1 + 2u + eps;
cpen;   top10y6 = m;   y7 = y6,   w10 draw 6 .7,                                  % bar
hpen;   x8 = x1;   bot0y8 = .5e;   w1 draw 2  8;                                 % stem
if w0 > 1.5u:   bot0y9 = 0;   x9 = r - 2.5u,   rt0x10 = r -  5u,   x11 = r + u,   y11 - e,
      new aa;   x10 = aa[x9, x11];   y10 = (sqrt(1 - aa aa))[y11, y9];
      draw |w1#|8{0, -1}. |w0#|9{1, 0}. 10(  11),                              % hook
else·   bot0y9 = - oo;   y10 = {e;   x9 -= 5[x8, x10],   x10  = good0(r - u),
      draw |w1#|8{0, --1}   |w0#|9{1, 0}   10{0, 1};                       % hook
fi.

"The letter u";
call charbegin(`u, 10, sc, sc, px, 0, px·slant +  5pwi + (sc - 2)pu),
hpen,   x1 = x2 = good1 2 5u,   x3 =- x4 = good1(r -  2 5u),   lft0x5 = lft1x1,
top1y1 = m,   m - y2 = ⅓[e, m];   m -- y5 = ⅓[e, m],  % prepare for upside down hstroke
x6 =  5[x2, x5];   bot0y6 = --oo;
x7 = 1/sqrttwo[x6, x2];   y7 = 1/sqrttwo[y2, y6];
draw |w0|5{0, -1}   |w0#|6{-1, 0}   | 6[w0, w1]|7{x2 -- x6, y2 -  y6}
      |w1#|2{0, 1}..1;                                               % stroke
y3 = y1;   bot1y4 = 0;   w1 draw 3 .4;                                  % stem
if lcs ≠ 0·   call `a serif(1, 1, 2, --lcs);                      % upper 'eft serif
      call `b serif(4, 1, 3, --lcs);                            % upper right serif
      call `c serif(3, 1, 4, lcs);                                 % lower serif
fi.
```

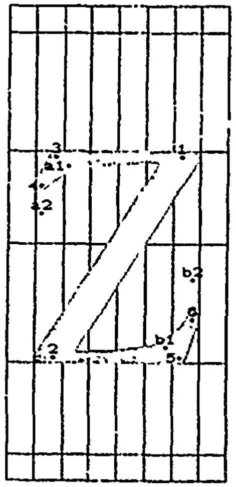




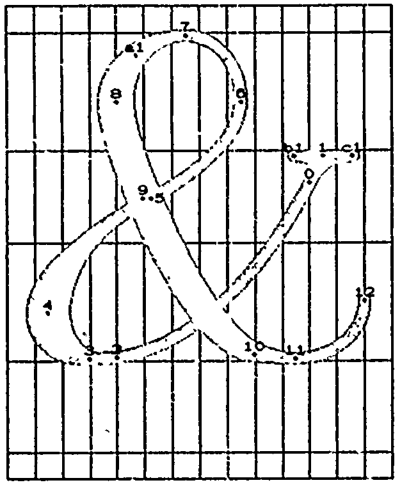
```
"The letter v";
call charbegin(`v, 10, sc, sc, px, 0, px·slant + 5pw + (lcs + sc - 1.5)pu),
hpen;   x1 = good1 2u,   x4 = good0(r + (lcs - lcss - 2)u),
x2 - x1 = x4 - x3,   lft0x3 = lft1x2,
top1y1 = m,   y4 = y1,   bot1y2 = -o,   y3 = y2,
w1 draw 1..2,                                          % left diagonal stroke
rpen#,   w1 draw 3..4;                        % erase excess at lower right
hpen,   w0 draw 3..4;                                 % right diagonal stroke
if lcs ≠ 0:   call `a serif(1, 1, 2, -lcs);
     call `b serif(1, 1, 2, lcs),                                 % left serif
     call `c serif(4, 0, 3, -lcs);
     call `d serif(4, 0, 3, lcss);                               % right serif
fi.

"The letter w";
call charbegin(`w, 13, sc, sc, px, 0, px·slant + 5pw + (lcs + sc - 1.5)pu),
hpen,   x1 = good1 2u;   rt0x9 = rt1x10,   x11 - x10 = x9 - x1,   x11 = r - (lcs - lcss - 2)u,
% x9, x10, and x11 are approximations to x4, x5, and x8.
x5 - x1 = x6 - x2 = x7 - x3 = x8 - x4 = round(x10 - x1),
% The idea is to draw two v's displaced by an integer amount
top1y1 = m,   bot1y2 = -o,   y4 = y6 = y7 = y2,   y1 = y5 = y8 = y1,
rt0x4 = rt1x5;   lft0x3 = lft1x2,   x2 - x1 = x4 - x3,
w1 draw 1..2;                                          % first diagonal
rpen#,   w1 draw 3..4;                                   % erase excess
hpen;   w0 draw 3..4;                                  % second diagonal
w1 draw 5..6,                                            % third diagonal
rpen#;   w1 draw 7..8,                                   % erase excess
hpen,   w0 draw 7..8;                                  % fourth diagonal
if lcs ≠ 0:   call `a serif(1, 1, 2, -lcs)
     call `b serif(1, 1, 2, lcs),                                 % left serif
     call `c serif(5, 1, 6, -lcss);
     call `d serif(5, 1, 6, lcs);                               % middle serif
     call `e serif(8, 0, 7, -lcs),
     call `f serif(8, 0, 7, lcss);                               % right serif
fi.
```

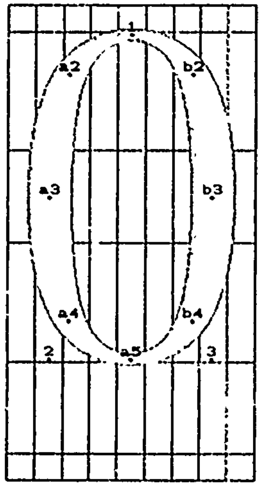




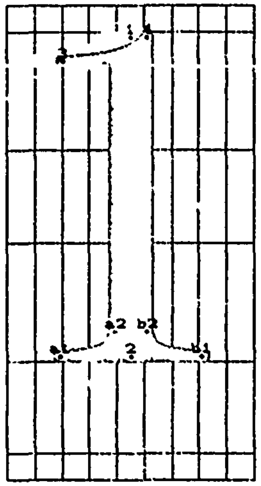


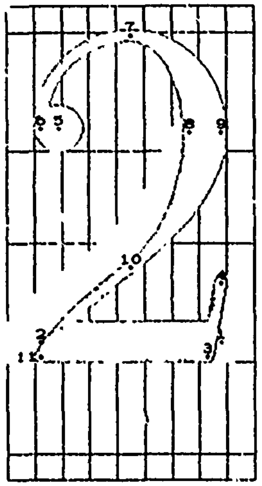
```
"The letter x";
call charbegin(`x, 10, sc, sc, px, 0, px slant + .5pwi + (sc + lcs − 2)pu),
hpen;   x1 = x3 = good1(2.5 − lcs + lcss)u,   x2 = x4 = r − x1,
top1y1 = top0y2 = m;   bot0y3 = bot1y4 = 0,
w1 draw 1..4;                                   % upper left to lower right diagonal
w0 draw 3..2;                                   % lower left to upper right diagonal
if lcs ≠ 0.   call `a serif(1, 1, 4, −lcss);
     call `b serif(1, 1, 1, 2[lcss, lcs]);                        % upper left serif
     call `c serif(4, 1, 1, −2[lcss, lcs]);
     call `d serif(4, 1, 1, lcss);                                % lower right serif
     new ss;   ss = .5(w1 − w0)/u;            % correction to lcs makes w0 like w1
     call `e serif(2, 0, 3, −2[lcss, lcs] − ss);
     call `f serif(2, 0, 3, lcss + ss);                           % upper right serif
     call `g serif(3, 0, 2, −lcss − ss);
     call `h serif(3, 0, 2, 2[lcss, lcs] + ss),                   % lower left serif
fi.

"The letter y";
call charbegin(`y, 10, sc, sc, px, pd, px·slant + .5pw + (lcs + sc − 1.5)pu),
hpen,   x1 = good1 2u,   x4 = good0(r + (lcs − lcss − 2)u);
x2 − x1 = x4 − x3;   lft0x3 = lft1x2,
top1y1 = m;   y4 = y1;   bot1y2 = −o;   y3 = y2,
w1 draw 1..2,                                             % left diagonal stroke
rpen#;   w1 draw 3..4;                              % erase excess at lower right
cpen;   lft1x8 = lft0x7 = round .25u;
bot1y8 = −.9d;   y7 = y8;   w1 draw 8;                                   % bulb
hpen;   x6 = 2u;   bot0y6 = −d − oo,   bot0y5 = −.5d;
new aa;   x5 = aa[x3, x4];   y5 = aa[y3, y4],
w0 draw 4..3{x4 − x3, y4 − y3}..6{−1, 0}..7{0, 1};      % right diagonal and tail
if lcs ≠ 0:   call `a serif(1, 1, 2, −lcs);
     call `b serif(1, 1, 2, lcs);                                       % left serif
     call `c serif(4, 0, 3, −lcs);
     call `d serif(4, 0, 3, lcss);                                     % right serif
fi.

"The letter z";
call charbegin(`z, 8, 0, 0, px, 0, px slant − .5pu);
hpen,   lft1x2 = round u,   rt1x1 = round(r − u),
top1y1 = m,   bot1y2 = 0,
new ss;   ss = 1.4aspect·lcs u + eps;
if ss + w0 > .25m:   new ss,   ss = .25m − w0 + eps;
fi;
lft0x3 = round 1.5u,   x4 = x3 − .5u;   y3 = y1,   y4 = y3 − ss/1.4;
rt0x5 = round(r − 1.5u),   x6 = x5 + .5u,   y5 = y2,   y6 = y5 + ss,
call `a arm(1, 3, 4);                                      % upper arm and serif
w1 draw 1..2;                                                 % diagonal stroke
call `b arm(2, 5, 6).                                      % lower arm and serif
```



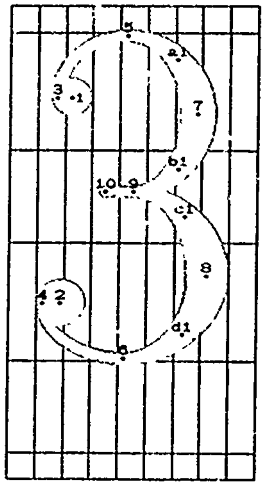


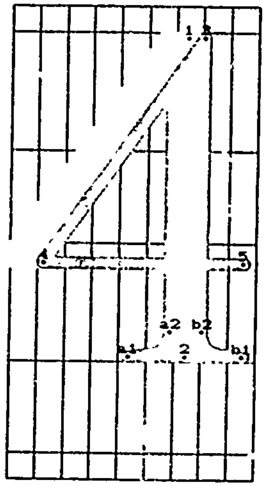
```
% This file contains the ten digits, as well as '&' and '?',
% in the so-called roman style.
% Codes '046, '060-'071, and '077 are used

"Ampersand";
call charbegin('046, 14, 0, 0, ph, 0, 5pc·slant + .5pw -- 5pu),
hpen;   x1 = r − 2 5u,   top0y1 = m;
x2 = 4u;   y2 = .015[y6, e];   x3 = 3u,   bot0y3 = −oo;
x4 = good2 1 5u;   y4 = ½[y3, y7];   x5 = 5 25u,   y5 = 5[y3, y7];
x6 = good0 8.5u;   y6 = 8[y3, y7];   x7 = 6 5u;   top0y7 = h + oo;
x8 = good1 4u,   y8 = y6;   x9 = x8 + u;   y9 = y5;   x10 = r − 5u,   y10 = 015[y3, y7];
x11 = x10 + 1 5u;   y11 = y1,   x12 = good0(r − u);   y12 = 5[y11, e],
if s = 0:   y0 = 1[y1, y2];
else:   y0 = y1 − s;
fi;
(x1 − x0)/(y1 − y0) = 5(x1 − x2)/(y1 − y2),
w0 draw 1 . 0;                                                      % short diagonal
draw 0{x0 − x1, y0 − y1}  |w0#|2 . |⅔[w0, w2]|3{−1, 0}  |w2#|4{0, 1}
     |w0#|5{x5 − x4, y5 − ½[y4, y7]}
     6{0, 1} . 7{−1, 0},                          % lower bowl and right part of upper bowl
call `a arc(7, 8, w1);                                        % left part of upper bowl
draw |w1|8{0, −1} . . 9  |w1#|10 . |w0#|11{1, 0} . 12{0, 1},                % long diagonal
if lcs ≠ 0:   call `b serif(1, 0, 0, −lcs);
     call `c serif(1, 0, 0, lcs),                                            % serif
fi.

"The numeral 0";
call charbegin('0, 9, 0, 0, ph, 0, ph·slant − .5pu);
if fixwidth = 0:   new save,   save = sqrttwo,   new sqrttwo,
     sqrttwo = sqrt(1.23114413save),                           % the constant is 2^1/10
fi;
hpen;
if w2 > 1.5u:   lft2x2 = round .75u;
else:   x2 = good2 1 5u,
fi,
x1 = r − x1;                                                % axis of left-right symmetry
x3 = r − x2;   top0y1 = h + oo,   bot0y2 = −oo,   y3 = y2;
call `a darc(1, 2, w2);   call `b darc(1, 3, w2),                                % bowl
if fixwidth = 0:   new sqrttwo,   sqrttwo = save;
fi.
```



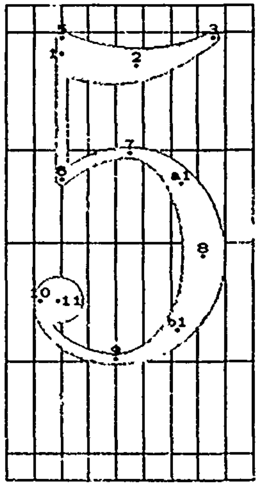


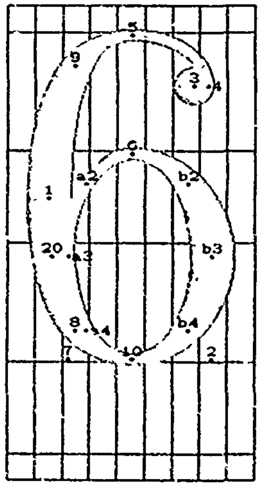
```
"The numeral 1",
call charbegin(`1, 9, 0, 0, ph, 0, ph·slant - .5pu);
hpen;   x1 == x2 == good2 .5r;   top2y1 == h,   bot2y2 == 0,
w2 draw 1 . 2;                                                          % stem
call `a serif(2, 2, 1, - 2),
call `b serif(2, 2, 1, 2);                                              % serif
if w0 == w2   if lcs = 0:   top0y3 == .8[m,h],   x4 == x1 - 2u - eps,
     else:   top0y3 == .2[m,h],   x4 == lft2x1 - 2u - eps,
     fi,
else:   top0y3 == .8[m,h];   x4 == x1 - 2.5u - eps,
fi;
y4 == y3;   rt2x1 == rt0x3,   y5 == .5[m,h],   x4 == x5,
ipen#,   w2 draw (5 . )4 . 3{ -1,0},                                    % erase excess
hpen;   w0 draw (5 . )4 . . 3{-1,0}.                                    % point

"The numeral 2";
call charbegin(`2, 9, 0, 0, ph, 0, ph·slant - .5pu);
vpen;   new w99,
if lcs = 0:   w99 == w1;
else:   w99 == w3;
fi;
rt99x1 = round(r - u);   lft99x2 = round u,   bot99y1 = 0;   y1 = y2;
w99 draw 1 . 2;                                                         % bar
if lcs ≠ 0:   x3 == x1,   top0y3 = top99y1 + ucs aspect u + eps,   bot0y4 = 0;
     if w7 == vw   x4 == x1;
     else:   x3 + .5u == x4,   rpen#;   w0 + .5u draw 3 . 4,           % erase excess
     fi;
     hpen;   w0 draw 3 . 4;                                             % serif
fi,
cpen;   bot1y5 == m;   lft1x5 == round u;
w1 draw 5,                                                              % bulb
hpen;   lft1x5 = lft0x6;   y5 == y6,
rt2x10 == rt0x9 == round(r - u),   lft2x10   lft0x8,   x7 = .5[x6,x9],   x11 = x2,
x10 == x7   top0y7 == h + oo,   y8 == y9   .7h,   bot0y11 == 0;   y10 = .4[y11,y9],
w0 draw 6{0,1} . . 7{1,0},                                              % shoulder
lpen#;   2u draw 9{0, - 1}   10{x10 - x9, 5(y10 - y9)}
        11{x11 - x10, 2(y11   y10)};                                    % erase excess
hpen,   w0 ddraw 7{1,0}   8{0, - 1}   10{x10   x9, 5(y10 - y9)},
     7{1,0} . . 9{0, -1}   10{x10 - x9, 5(y10 - y9)},                  % stroke
draw 10{x10 - x9, 5(y10 - y9)}   11{x11 - x10, 2(y11 - y10)}            % link
```



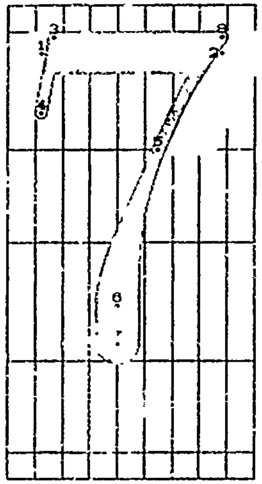


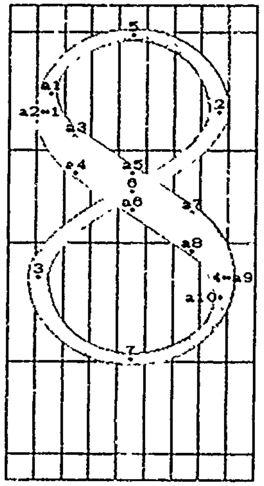
```
"The numeral 3",
call charbegin(`3, 9, 0, 0, ph, 0, ph slant - 5pu);
new w99,   w99 = round 75[w0, w1],
cpen;   bot99y1 = 75h,
if top99y1 > 9h   new y1;   top99y1 = 9h,
fi;
lft99x1 = round 1.5u,   w99 draw 1,                                      % upper bulb
top1y2 = 25h;
if bot1y2 < 1h   new y2,   bot1y2 = 1h,
fi;
lft1x2 = round u;   w1 draw 2,                                            % lower bulb
hpen;   lft0x3 = lft99x1,   lft0x4 = lft1x2,   y3 = y1,   y4 = y2,
x5 = 5[x3, x7],   x6 = 5[x4, x8],   top0y5 = h + oo,   bot0y6 = oo,
rt1x7 = round(r - 1 5u),   rt2x8 = round(r - u),   y7   5[y9, y5],   y8   5[y10, y6],
y9 = y10 = good0 52h;   x10 + u = x9 = 5r,
w0 draw 3{0, 1}   5{1, 0};                                               % shoulder
call `a arc(5, 7, w1),   call `b arc(9, 7, w1);                          % upper bowl
w0 draw 9 . 10;                                                          % bar
call `c arc(9, 8, w2),   call `d arc(6, 8, w2),                          % lower bowl
w0 draw 6{-1, 0}   4{0, 1}.                                              % tail

"The numeral 4",
call charbegin(`4, 9, 0, 0, ph, 0, ph slant - 5pu),
hpen,   x1 = x2,
if lcs ≠ 0:   if w2 > 1.5u   rt2x1 = round(r - 1.75u),
      else   x1 = good2 6 5u,
      fi;
else   x1 = good2 6 5u;
fi,
top2y1 = h,   bot2y2 = 0,
rt2x1 = rt0x3,   y1 = y3,   y4 = y5   good0 3e,   lft0x4 = round u,
w2 draw 1   2,                                                           % stem
lpen#,   w2 draw 2   4;                                   % erase excess at upper left
hpen;   w0 draw 3   4,                                                   % diagonal
if lcs ≠ 0:   rt0x5 = rt2x2 + 1 5u + eps,
      call `a serif(2, 2, 1,   1 5),
      call `b serif(2, 2, 1, 1 5),                                       % serif
else   rt0x5 = round(r - 75u),
fi,
w0 draw 4   5                                                            % bar
```



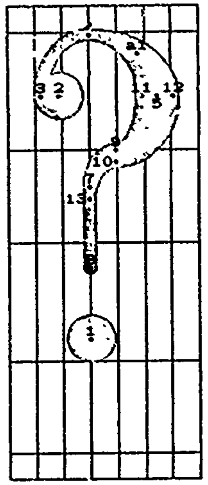


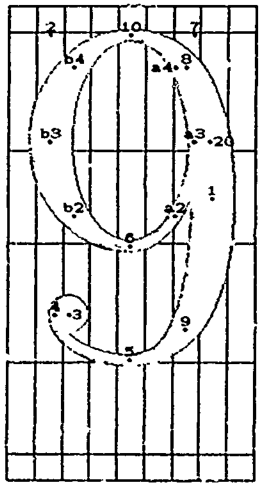
```
"The numeral 5";
call charbegin(`5, 9, 0, 0, ph, 0, ph·slant − 5pu);
vpen,   x_1 = good_0 2u,   top_8 y_1 = h;   rt_0 x_3 = round(r − 1 25u);   top_0 y_3 = h,
x_2 = 5[x_1, x_3];   new w_99,   w_99 = round 75[w_0, w_3];   top_99 y_2 = round .95h;
x_0 = −.5u,   x_4 = r + 1 5u,   y_0 = y_4 = 1.5h;
draw (|w_3|0 . . )1 . . |w_99|2 . |w_0|3( . 4);                                  % arm
hpen;   x_5 = x_6 = x_1,   top_0 y_5 = h;   top_0 y_6 = 75[e, m];
x_7 = .5r;   top_0 y_7 = m + oo;   x_9 = x_7 − 5u,   bot_0 y_9 = −oo.
rt_2 x_8 = round(r − u);   y_8 = .5[y_7, y_9];
w_0 draw 5 . 6;                                                                    % stem
draw (9 . )6   7{1, 0},                                             % left part of bowl
call `a arc(7, 8, w_2);   call `b arc(9, 8, w_2),              % right part of bowl
lft_0 x_10 = lft_3 x_11 = round u,   y_10 = y_11 = ⅓y_6;
w_0 draw 9{−1, 0}   10{0, 1};                                                      % tail
cpen;   w_3 draw 11                                                                % bulb

"The numeral 6";
call charbegin(`6, 9, 0, 0, ph, 0, ph·slant − 5pu),
if w_2 > 1 5u:   lft_2 x_1 = round 75u,   rt_2 x_2 = round(r − 75u);
else   x_1 = good_2 1 5u,   x_2 = good_2(r − 1 5u),
fi,
new w_99,   w_99 = round 75[w_0, w_3],
cpen,   top_3 y_3 = h − .25e;
if y_3 < 5[m, h]   new y_3,   y_3 = 5[m, h];
fi;
rt_99 x_3 = rt_0 x_4 = round(r − 1 5u);   y_4 = y_3,
w_99 draw 3;                                                                       % bulb
hpen,   x_20 = good_2(x_1 + 1u),   x_5 = x_6 = x_10 = 5[x_20, x_2],   top_0 y_5 = h + oo,
w_0 draw 4{0, 1}   5{−1, 0};                                                   % shoulder
bot_0 y_2 = −oo;   top_0 y_6 = m + oo,   y_20 = 5[y_2, y_6],
y_7 = y_2 = y_10,   rt_0 x_7 = rt_2 x_20;
call `a darc(6, 7, w_0),   call `b darc(6, 2, w_2),                             % bowl
new w_99;   w_99 = ⅔[w_0 w_2];              % intermediate width used in darc routine
x_8 = x_9;   rt_99 x_8 = rt_0(1/sqrttwo[x_6, x_7]);
y_8 = 1/sqrttwo[y_20, y_7];   y_5 − y_9 = y_8 − y_7,   y_1 = 5[y_5, y_10];
draw |w_0#|5{−1, 0} . |w_99|9{x_7 − x_6, y_7 − y_20}   |w_2#|1{0, −1}
        |w_99|8{x_6 − x_7, y_7 − y_20}   |w_0#|10{1, 0}                     %   roke
```



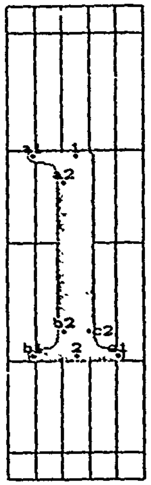


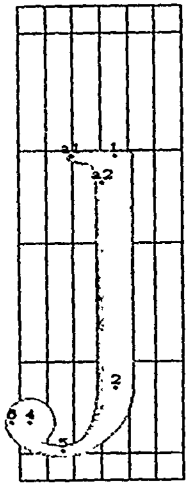
```
 The numeral 7";
call charbegin('7, 9, 0, 0, ph, 0, ph slant - 5pu);
vpen,   new w99,
if lcs = 0    w99 = w5,
else.   w99 = w8,
fi;
lft99x1 = round u,   rt99x2 = round(r - u),   top99y1 = h,   y2 = y1,
w99 draw 1   2;                                                        % bar
if lcs ≠ 0:   x1 = x1,   bot0y1 = bot99y1 - ucs aspect u - eps,   top0y3 = h,
     if w7 = w8    x3 = x1;
     else    x3 - 5u = x1,   lpen#,   w0 + 5u draw 3   4,              % erase excess
     fi,
     hpen,   w0 draw 3   4;                                            % serif
fi;
cpen;   bot2y7 = -oo,   bot2y6 = 1/6m,   x6 = x7   good2 4u;
w2 draw 7   6,                                                         % bulb
hpen;   x5 = 5 5u,   y5 = m,   top0y8 = h,   x8 = x2,
rpen#,   2u draw 8{x5 - x8, 2/3(y5 - y8)}   5(   6),                   % erase excess
hpen,   draw |w0|8{x5 - x8, 2/3(y5 - y8)}   |w0#|5   |w2#|6{0, - 1}    % stroke

"The numeral 8".
call charbegin('8, 9, 0, 0, ph, 0, ph slant - 5pu),
new w98, w99, ss,   w99 = round 1/3[w0, w1];
hpen;   lft99x1 = round u,   x2 = r - x1,   y1 = y2,
lft99x3 = round 75u,   x4 = r - x3,   y4 = y3,   x5 = r - x5 = x6 = x7,
top0y5 = h + oo;   y6 = 52h,   bot0y7 = -oo,
w98 = 2[w7, w8];
if w0 = w98   ss = 0,
else    ss = h/(18u),                                                  % slope
fi;
call "a sdraw(5, 1, 6, 4, 7, w99, w98, -ss),        % upper left and lower right strokes
w99 draw 5{1, 0}   2{0, -1}   6{- 1, - 75ss}
     3{0, -1}   7{1, 0}                             % upper right and lower left strokes
```

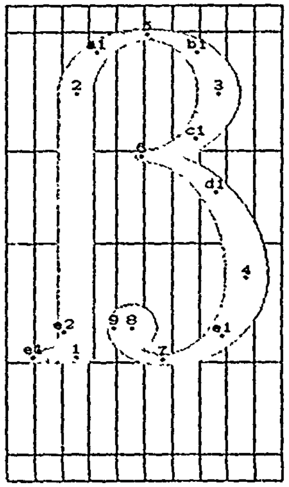




```
"The numeral 9";
call charbegin(`9, 9, 0, 0, ph, 0, ph·slant — .5pu);
if w_2 > 1.5u·   rt_2x_1 = round(r — 75u);   lft_2x_2 = round 75u,
else·  x_1 = good_2(r — 1 5u);   x_2 = good_2 1 5u,
fi;
new w_99;   w_99 = round .75[w_3, w_1];
cpen,   bot_99y_3 = .25e;
if y_3 > 5e:   new y_3,   y_3 = .5e,
fi,
lft_99x_3 = lft_0x_1 = round 1.5u;   y_1 = y_3;
w_99 draw 3;                                                       % bulb
hpen;   x_20 = good_2(x_1 — 1u);   x_4 = x_6 = x_10 = 5[x_20, x_2];   bot_0y_5 = — oo,
w_0 draw 4{0, —1} . . 5{1, 0};                                     % tail
top_0y_2 = h + oo;   y_6 = e — oo;   y_20 = 5[y_2, y_6],
y_7 = y_10 = y_2,   lft_0x_7 = lft_2x_20,
call `a darc(6, 7, w_0);   call `b darc(6, 2, w_2),               % bowl
new w_99;   w_99 = ⅔[w_0, w_2];                % intermediate width in darc routine
x_8 = x_9;   lft_99x_8 = lft_0(1/sqrttwo[x_6, x_7]);
y_8 = 1/sqrttwo[y_20, y_7];   y_5 — y_9 = y_8 — y_7,   y_4 = 5[y_5, y_10],
draw |w_0#|5{1, 0}   |w_99|9{x_7 — x_6, y_7 — y_20}   |w_2#|1{0, 1}
      . |w_99|8{x_6 — x_7, y_7 — y_20}   |w_0#|10{—1, 0}.            % stroke

"Question mark";
call charbegin('077, 7, 0, 0, ph, 0, 8ph·slant + 5pwii — pu),
new w_99, w_98,   w_98 = round .4[w_0, w_2];
if w_1 < w_0 sqrt 2·   w_99 = w_0 sqrt 2,
else   w_99 = w_3,
fi;
cpen,   bot_99y_1 = 0;   x_1 = good_0 5(r — u);
w_99 draw 1;                                                       % dot
lft_3x_2 = lft_0x_3 = round u,   y_2 = y_3 = 8[top_99y_1, bot_0y_1];   top_0y_4 = h + oo,
w_1 draw 2;                                                        % bulb
hpen,   x_4 = .5(r — u);   x_5 = good_2(r — 1 5u),   y_5 = y_2;
w_0 draw 3{0, 1} . . 4{1, 0};   call `a arc(4, 5, w_2);          % bowl
lft_0x_11 = lft_2x_5,   rt_0x_12 = rt_2x_5;   y_11 = y_12 = y_5;
cpen;   top_6y_9 = top_98y_8;   bot_0y_10 = bot_98y_8,
x_9 = x_10 = x_7            x_7 = x_8 = x_11 = x_1,   y_11 — y_7 = y_10 — y_9,
y_4 — y_7 = y_7             top_0y_7 = top_98 ½[y_4, y_8],   bot_0y_8 — 25[top_99y_1, m] + 1,
hpen;   w_0 dr           '0, —1}   9{—1, 0}   7{0, —1},
     12{0, —1}   1   -1, 0}   13{0, —1};                         % link and stem
draw 13 . . 8.                                                     % point
```

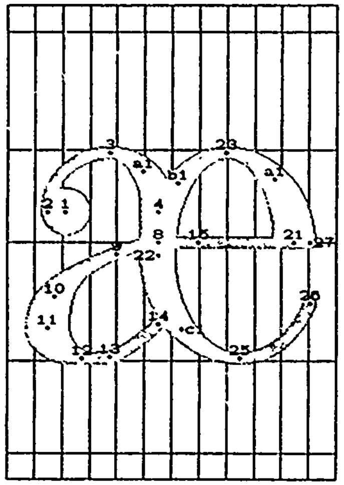




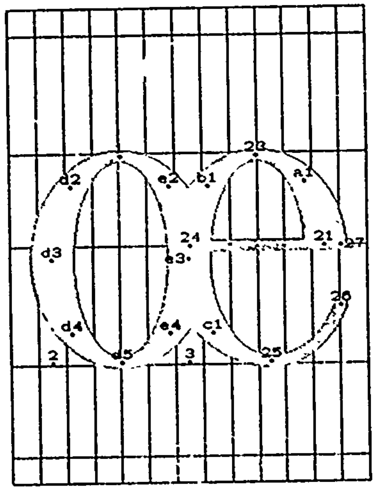


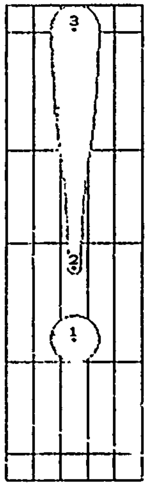
The file romans mf

```
% This file contains special letters and letter combinations,
% compatible with the alphabet "romanl"
% Codes '013, '014, '033-'035 are used.

"Dotless letter i";
call charbegin('013, 5, sc, sc, px, 0, px slant + 5pwi + (sc -- 2)pu),
hpen;   x1 = x2 = good1 5r,   top1y1 = m,   bot1y2 = 0;
w1 draw 1 . 2;                                                     % stem
if lcs ≠ 0.   call `a serif(1, 1, 2, --lcs);                       % upper serif
     call `b serif(2, 1, 1, -lcs),
     call `c serif(2, 1, 1, lcs);                                  % lower serif
fi.

"Dotless letter j",
call charbegin('014, 6, sc, 0, px, pd, px slant + 5pwi - 2pu),
hpen,   x1 = x2 = good1(r - 2 5u),
if fixwidth = 0    lft1x1 = round(-- 5u);
else    lft1x1 = round u,
fi;
cpen;   bot3y1 = -- 9d,   w1 draw 4,                               % bulb
hpen;   top1y1 = m;   bot1y2 = -1/4d,
bot0y5 = -d - oo;   y1 = y6,   lft0x6 = lft1x1,   x5 = 5[x2, x4],
draw |w1|1   |w1#|2{0, --1}   |w0#|5{-1, 0}   6{0, 1},             % stem and tail
if lcs ≠ 0·   call `a serif(1, 1, 2, -lcs),                        % serif
fi.

"The German letter ss";
call charbegin('033, 10, sc, 0, ph, 0, ph slant - pu),
hpen;   x1 = x2 = good1 2 5u,   rt2x3 = round(r - 1 5u),   rt2x4 - round(r -  5u),
bot1y1 = 0;   y2 = 5[m, y5],
top0y5 = h + oo;   x5 = 5[x2, x3],   y3 -- 5[m, y5],   y4 = 4m,
w1 draw 1 . 2;                                                     % stem
call `a arc(5, 2, w1);                                             % shoulder
top0y6 = m,   lft0x6 -- round(rt1x2 + 1 5u),
call `b arc(5, 3, w2),   call `c arc(6, 3, w2),                    % upper bowl
cpen,   lft1x8 = round(rt1x1 + 5u),   bot1y8 = 1e,
w3 draw 8;                                                         % bulb
hpen,   lft0x9 - lft1x8,   y9 - y8,   x7 -  1[lft0x9, x1],   bot0y7     oo,
call `d arc(6, 4, w2);   call `e arc(7, 4, w2);                    % lower bowl
w0 draw 7{-1, 0}   9{0, 1},                                        % link
if lcs ≠ 0.   call `e serif(1, 1, 2, -lcs),                        % serif
fi.
```



```
 The ligature ae";
call charbegin('034, 12, 0, 0, px, 0, pe·slant + lcic);
cpen;  lft3x1 = round 1.25u;
if top3(top1top6e + 2) > .9[e, m].   top3y1 = .9[e, m];
else.   y1 = top3top6e + 2;
fi;
w3 draw 1;                                                                    % bulb
hpen;  lft0x2 = lft3x1;   y2 = y1;   x3 = 3.75u;   top0y3 = m + oo;
x4 = good1 5.5u;   y4 = 1/3[e, m],
w0 draw 2{0, 1}..3{1, 0};   call `a arc(3, 4, w1);                       % shoulder
x8 = x4,   y8 = e,   w1 draw 4   8;                                          % stem
x9 = 4u;   y9 = .9[w0, y8];   x10 = x11 + 25u,   y10 - 5[w0, y8],
x11 = good2 1 5u,   y11 = 2[w0, y8],
x12 = 2 75u;   bot0y12 = -oo;   x13 = 3 75u;   y13 = .015[y12, y8];
x14 = x8;   y14 = 3[y12, y8];   x15 = 7u;   y15 = e;
draw |w0|8{-1, 0}  .|w0#|9.  |8[w0, w2]|10   |w2#|11{0, -1}..
     |.7[w0, w2]|12{1, 0}   |w0#|13   14( .15);                          % left bowl
if w2 > 1 5u:   rt2x21 = round(r - 75u);
else   x21 = good2(r - 1.5u);
fi;
x22 = x1,   x23 = r - 4u,   top0y23 = m + oo;   y21 = e,   y22 = 5[y25, y23],
bot0y25 = -oo,   x25 = x23 + .5u;
call `a arc(23, 21, w2);                                                   % right bowl
call `b arc(23, 22, w1);   call `c arc(25, 22, w1);                            % stroke
w0 draw 8..21;                                                                 % bar
if w0 = w1·   x26 = x21;   x27 - x25 = x21 - x23;   y27 = y22;
     new aa,   x26 = aa[x25, x27],   y26 = (sqrt(1 - aa aa))[y27, y25],
else   rt0x26 = rt2x21;   x27 = x26,   y26 = 5e - 1,   y27 = e,
fi,
w0 draw 25{1, 0}   26(..27)                                                  % point
```

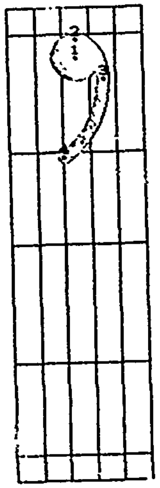


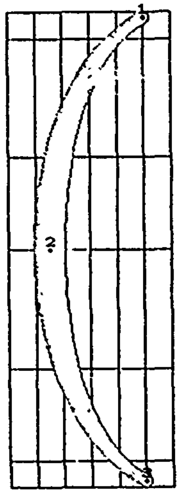


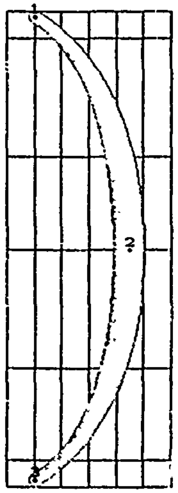
```
"The ligature oe",
call charbegin('035, 13, 0, 0, px, 0, pe·slant + !cic);
hpen,   x_3 = good_2 .5r;
if w_2 > 1.5u:   lft_2 x_2 = round .75u   rt_2 x_21 = round(r − .75u);
else.   x_2 = good_2 1.5u;   x_21 = good_2(r − 1.5u),
fi;
x_1 − x_2 = x_3 − x_1,
top_0 y_1 = m + oo;   bot_0 y_2 = −oo,   y_2 = y_3;
call 'd darc(1, 2, w_2);                                       % left part of left bowl
call 'e darc(1, 3, w_2),                                      % right part of right bowl
x_22 = x_3;   x_23 = r − .4u;   top_0 y_23 = m + oo,   y_21 = e;   y_22 = .5[y_25, y_23],
bot_0 y_25 = −oo;   x_25 = x_21 + .5u,
call 'a arc(23, 21, w_2),                                                  % right bowl
call 'b arc(23, 22, w_2),   call 'c arc(25, 22, w_2),                       % stroke
new aa,   y_24 = y_21 = aa[y_22, y_23],   x_24 − 1 = (sqrt(1 − aa aa))[x_23, x_22],
w_0 draw 24 .. 21;                                                           % bar
if w_0 = w_1:   x_26 = x_21,   x_27 − x_25 = x_21 − x_23,   y_27 = y_22,
     new aa,   x_26 = aa[x_25, x_27],   y_26 = (sqrt(1 − aa aa))[y_27, y_25],
else   rt_0 x_26 = rt_2 x_21,   x_27 = x_26,   y_26 = .5e − 1,   y_27 = e,
fi;
w_0 draw 25{1,0} .. 26 .. 27)                                              % point
```

The file romitp mf

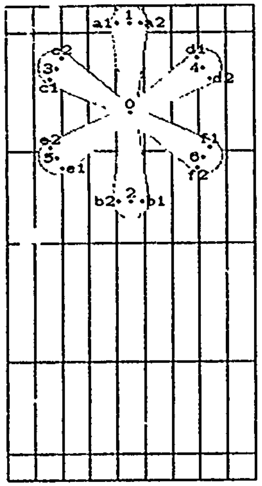
```
% This file contains punctuation marks common to roman and
% italic styles, including math italic and fixed-width fonts
% Codes '041, '047 '054, '056, '057, '072 '076, '133, '135, '140 are used

"Exclamation point";
call charbegin('041, 5, 0, 0, ph + pb, 0, (ph + pb) slant + .5pwm − .2pu),
new w_99;
if w_3 < w_0 sqrt 2:   w_99 = round w_0 sqrt 2;
else.   w_99 = w_3;
fi;
cpen;   x_1 = x_2 = x_3 = good_99 2.5u,   bot_0 y_1 = 0,   w_99 draw 1,            % dot
top_99 y_3 = h + b,   bot_0 y_2 = .25[top_99 y_1 + i m],
w_99 draw 3,                                                            % top of stem
hpen,   draw |w_99|3 .. |w_0|2                                               % stem
```

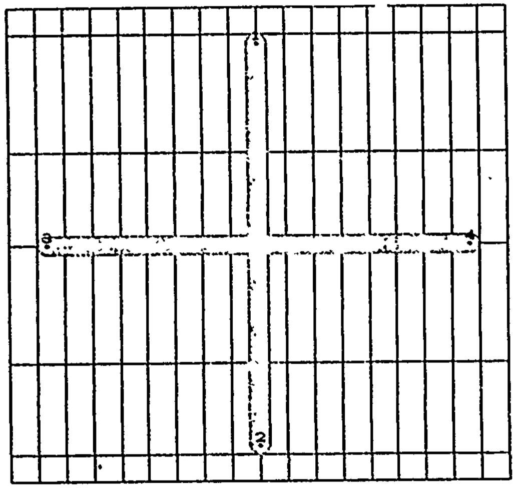


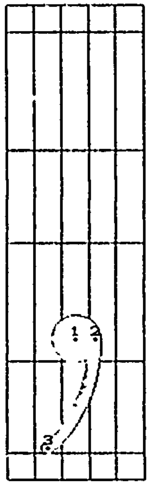




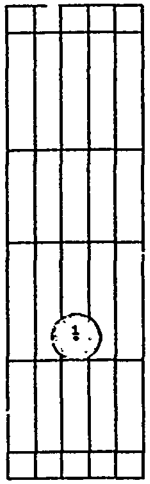
```
"Apostrophe";
call charbegin('047, 5, 0, 0, ph, 0, 2/3[px, ph]·slant + 5pw — pu);
% There is rotational symmetry with respect to reverse apostrophe.
new v;   v = fixwidth[u, 5/3u];             % unit width adjusted to agree with closing quotes
cpen,   top3y1 = top6y2 = h;   top0y3 = m;   y4 = 2/3[y1, y2];
x1 = x2 = good1.5r;   x3 = good0(x1 + v + eps),   x4 = x1 — 5v — eps;
w3 draw 1;                                                                          % bulb
hpen,   w0 draw 2{1, 0} .3{0, —1} .4{3(x4 — x3), y4 — y3}.                          % tail

"Left parenthesis",
call charbegin('050, 6, 0, 0, ph + pb, ph + pb — 2pa, (ph + pb) slant + 5pw — 5pu),
% There is left-right symmetry with respect to right parenthesis.
hpen;   x1 = x3 = good0(r — u);
top0y1 = h + b;   y2 = a = 5[y1, y3];   y0 = y1,   y4 = y3,
new v;                                  % unit width corrected for fixed width option
if fixwidth = 0·   v = u;
else.   v = 8/9u;
fi,
new w99,   w99 = round 75[w0, w1],   lft99x2 = round(x1 — 4v),
x0 = x4 = x1 + 7.5v,
draw (0 .)|w0|1 . |w99#|2  |w0|3( . 4).                                            % stroke

"Right parenthesis";
call charbegin('051, 6, 0, 0, ph + pb, ph + pb — 2pa, pa·slant — .5pu),
% There is left-right symmetry with respect to left parenthesis
hpen;   x1 = x3 = good0u;
top0y1 = h + b;   y2 = a = 5[y1, y3];   y0 = y1,   y4 = y3;
new v;                                  % unit width corrected for fixed wi 'th option
if fixwidth = 0:   v = u,
else·   v = 8/9u,
fi;
new w99;   w99 = round .75[w0, w1];   rt99x2 = round(x1 + 4v);
x0 = x4 = x1 — 7.5v;
draw (0 .)|w0|1 . . |w99#|2 . |w0|3( . 4).                                          % stroke
```

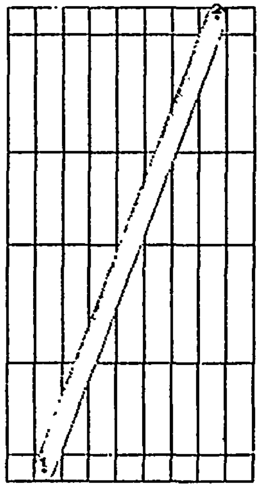


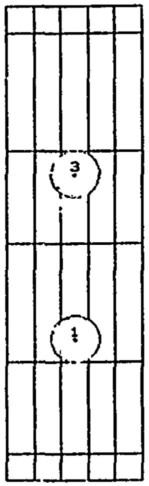


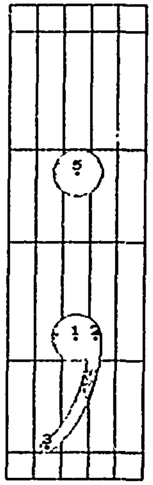


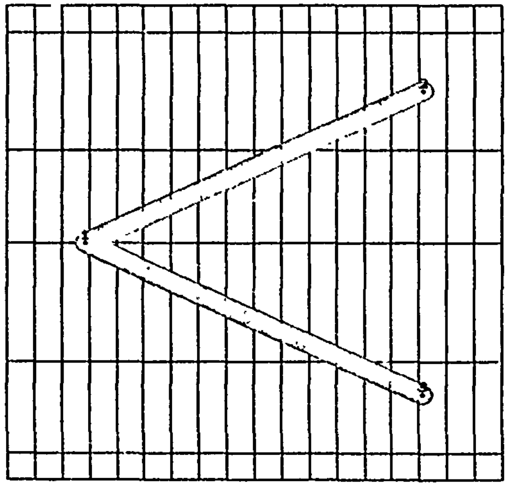
```
"Asterisk";
call charbegin('052, 9, 0, 0, lowast[ph + pb, pa + 5px], 0,
                    (lowast[ph + pb, pa + 5px] - .25px)·slant - (4 - 1.875 sqrt 3)pu);
cpen;   top_1 y_1 = lowast[h + b, round(a + 5m)];   top_1 y_1 -- bot_1 y_2 = m;
y_0 = 5[y_1, y_2];   x_0 = r - x_0;   x_1 = x_2 = x_0;
x_3 = r - x_1,   x_5 = r -- x_6;   x_3 = x_5;                          % left-right symmetry
y_3 = y_4,   y_5 = y_6;   y_1 - y_5 = y_1 - y_0,   5[y_3, y_5] = y_0;
x_1 - x_0 = (.5 sqrt 3)lft_1 3.75u;            % asterisk will have 60-degree angles if m = 7 5u
call `a cdraw(1, 0, 1, 0),                                                       % upper arm
call `b cdraw(2, 0, 1, 0),                                                       % lower arm
call `c cdraw(3, 0, 1, 0);                                                  % upper left arm
call `d cdraw(4, 0, 1, 0),                                                 % upper right arm
call `e cdraw(5, 0, 1, 0);                                                  % lower left arm
call `f cdraw(6, 0, 1, 0)                                                  % lower right arm

"Plus sign",
cpen;
if fixwidth = 0·   if pa + 8pu > ph:
          call charbegin('053, 18, 0, 0, ph, ph -- 2pa, pa slant -- 5pu),   top_10 y_1 = h,
     else    call charbegin('053, 18, 0, 0, pa + 8pu, 8pu -- pa, pa slant - 5pu),
          top_10 y_1 = a + 8u;
     fi,
else    call charbegin('053, 9, 0, 0, 3 5pu + pa, 3 5pu - pa, 0);   top_10 y_1 = a + 3 5u;
fi,
.5[y_1, y_2] = a;   x_1 = x_2 = 5r,
lft_10 x_3 = round u;   x_4 = r - x_3;   y_3 = y_4 = a,
w_10 draw 1 . 2,                                                                     % stem
draw 3   4.                                                                           % bar

"Comma",
call charbegin('054, 5, 0, 0, 1.5pwin, pdd, 0),
cpen,   new w_99;
if w_3 < w_0 sqrt 2    w_99 = round w_0 sqrt 2,
else.   w_99 = w_3,
fi;
x_1 = good_99 5r,   bot_99 y_1 = 0;   w_99 draw 1,                                       % bulb
y_2 = y_1,   rt_99 x_1 = rt_0 x_2,
if fixwidth = 0·   x_3 = good_0 1 5u,
else.   x_3 = good_0 15/18 u;
fi,
hpen,   bot_0 y_3 = - dd,
w_0 draw 2{0, -1}  .3{3(x_3    x_2), y_3 -   y_2}                                     % point
```



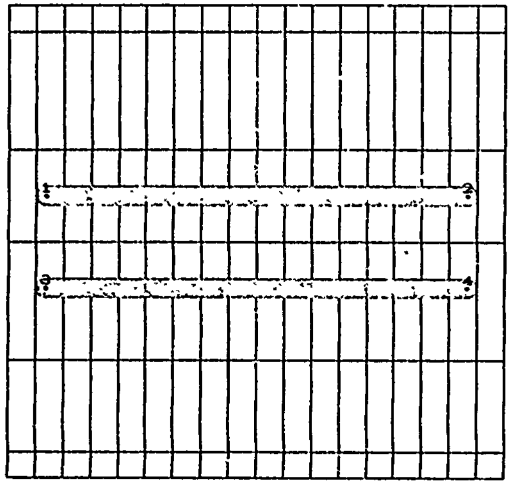


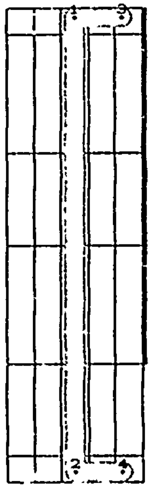


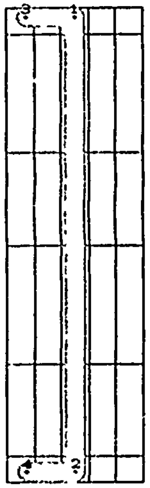


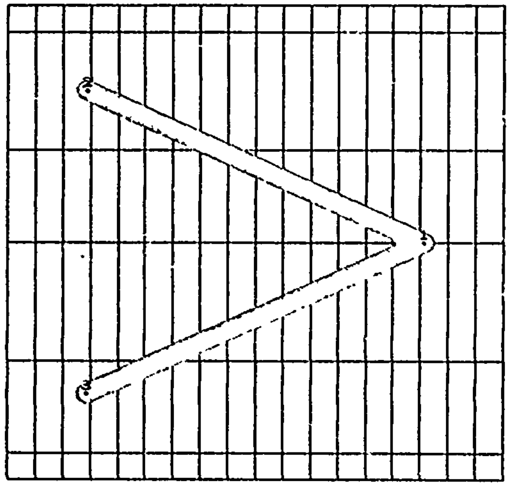


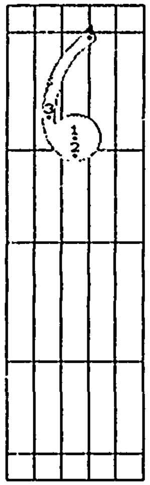
```
"Period";
call charbegin('056, 5, 0, 0, 1.5pwiii, 0, 0),
cpen,   new w99;
if w1 < w0 sqrt 2:    w99 = round w0 sqrt 2,
else:   w99 = w1;
fi;
x1 = good99 .5r;   bot99y1 = 0,   w99 draw 1.                                   % [illegible]

"Virgule (slash)";
call charbegin('057, 9, 0, 0, ph + pb, ph + pb − 2pa, (ph + pb) slant − 5pu);
cpen;   lft10x1 = round u,   x2 = r − x1,
top10y2 = h + b;   .5[y1, y2] = a;
w10 draw 1 . . 2.                                                            % diagonal

"Colon";
call charbegin('072, 5, 0, 0, px, 0, px slant + 5pwiii sqrt 2 − 2pu),
cpen;   new w99;
if w1 < w0 sqrt 2:    w99 = round w0 sqrt 2;
else:   w99 = w1;
fi;
x1 = good99 5r,   bot99y1 = 0;   w99 draw 1,                                  % upper dot
x3 = x1;   top99y3 = m,   w99 draw 3.                                          % lower dot

"Semicolon";
call charbegin('073, 5, 0, 0, px, pdd, px slant + 5pwiii sqrt 2 − 2pu),
cpen;   new w99;
if w1 < w0 sqrt 2:    w99 = round w0 sqrt 2;
else:   w99 = w1;
fi;
x1 = good99 5r,   bot99y1 = 0,   w99 draw 1;                                   % bulb
x5 = x1,   top99y5 = m,   w99 draw 5;                                          % dot
y2 = y1;   rt99x1 = rt0x2,
if fixwidth = 0:   x3 = good0 1.5u;
else.   x3 = good0 17/18u;
fi,
hpen;   bot0y3 = −dd;
w0 draw 2{0, −1} . 3{3(x3 − x2), y3 − y2}                                      % p[illegible]

"Less than sign";
call charbegin('074, 18, 0, 0, 5[px, ph] + prt/2,
                    5[px, ph] + prt/2 − 2pa, .5[px, ph]·slant   2pu),
cpen;   lft10x1 = round 2 5u,   x2 = x3 = r − x1,
y2 = good10 5[m, h];   .5[y2, y3] = y1 = good10a;
w10 draw 2 . 1 . . 1 . . 3.                                                   % diag[illegible]
```



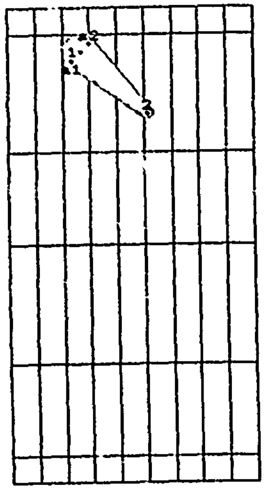


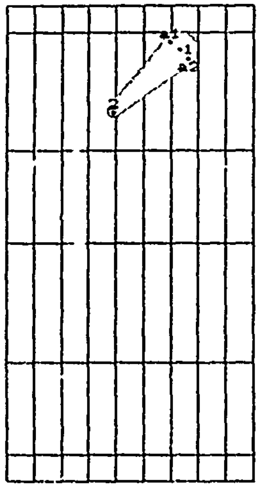


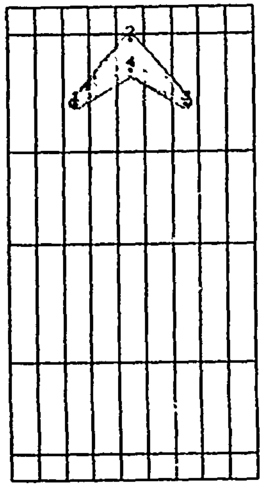


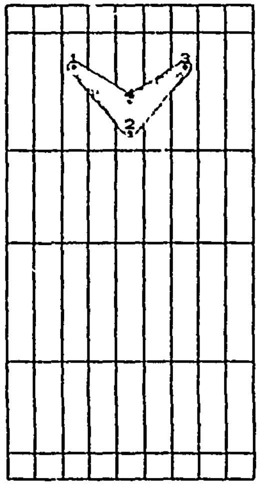


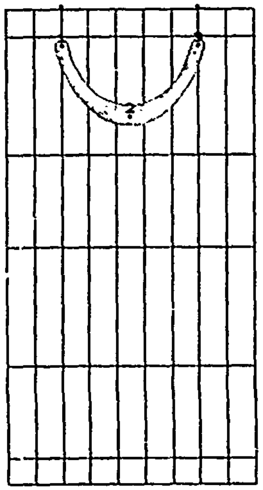
```
"Equal sign",
call charbegin('075, 18, 0, 0, pa + .5(px − pe) + prt/2, 0, (pa + .5(px − pe)) slant − .5pu),
cpen;   lft_10 x_1 = round u,   x_3 = x_1,   x_2 = x_4 = r − x_1;
y_1 = y_2,   y_3 = y_4;   y_1 − y_3 = round(m − e);   .5[y_1, y_3] = a,
w_10 draw 1..2;                                                              % upper bar
draw 3..4.                                                                   % lower bar

"Greater than sign";
call charbegin('076, 18, 0, 0, .5[px, ph] + prt/2,
                    .5[px, ph] + prt/2 − 2pa, pa slant − 2pu);
cpen,   lft_10 x_2 = round 2.5u,   x_3 = x_1 = r − x_1,
y_2 = good_10 .5[m, h],   .5[y_2, y_3] = y_1 = good_10 a;
w_10 draw 2..1..3                                                            % diagonals

"Left bracket";
call charbegin('133, 5, 0, 0, ph + pb, ph + pb − 2pa,
                    (ph + pb) slant + prt/2 − 2.5pu),
cpen;   x_1 = x_2 = good_10 .5r,   x_3 = x_4 = x_1 + 1.75u + eps,
top_10 y_1 = h + b;   .5[y_1, y_2] = a,   y_3 = y_1;   y_4 = y_2,
w_10 draw 3..1..1..2..2..4                                                   % stem and points

"Right bracket",
call charbegin('135, 5, 0, 0, ph + pb, ph + pb − 2pa,
                    (ph + pb) slant + prt/2 − 2pu),
cpen;   x_1 = x_2 = good_10 .5r,   x_3 = x_4 = x_1 − 1.75u − eps,
top_10 y_1 = h + b,   .5[y_1, y_2] = a,   y_3 = y_1;   y_4 = y_2,
w_10 draw 3..1..1..2..2..4                                                   % stem and points

"Reverse apostrophe";
call charbegin('140, 5, 0, 0, ph, 0, ph slant + .5pw − 1.5pu);
% There is rotational symmetry with respect to apostrophe
new v,   v = fixwidth[u, 2/3 u],               % unit width adjusted to agree with opening quotes
cpen;   bot_3 y_1 = bot_0 y_2,   top_0 y_3 = h,   y_4 = 2/3[y_1, y_2],   y_2 − y_1 = m − h;
x_1 = x_2 = good_3 .5r,   x_3 = good_0(x_1 − v − eps),   x_4 = x_1 + .5v + eps,
w_3 draw 1;                                                                  % bulb
hpen;   w_0 draw 2{−1, 0}..3{0, 1}..4{3(x_4 − x_3), y_4 − y_3}               % tail
```





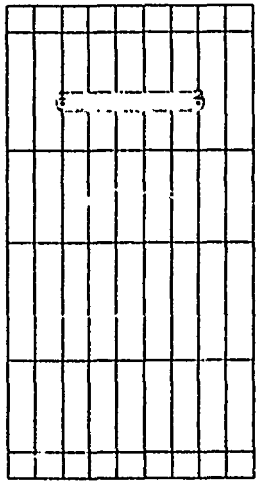


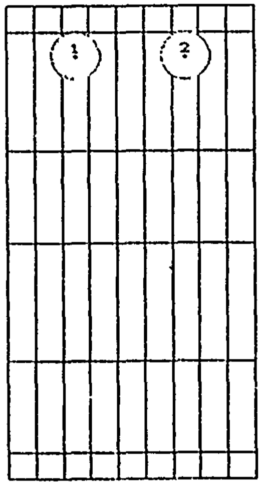


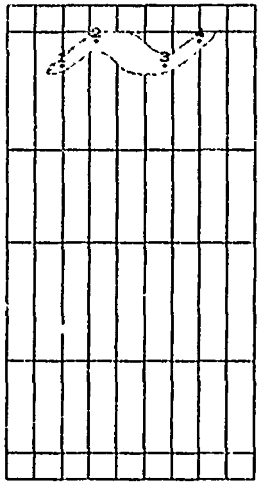


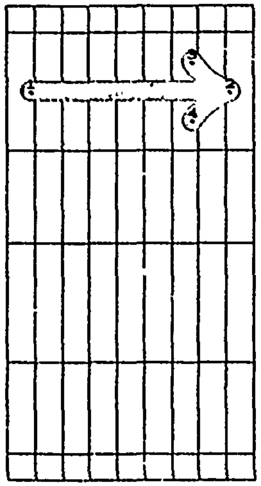
The file romita mf

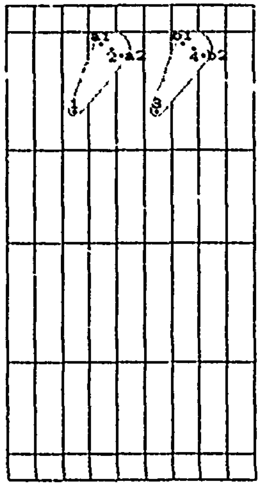
```
% This file contains accents common to text roman and italic fonts.
% It also contains the 'Æ', 'Œ', and '%', since these symbols are common
% to the same fonts that the accents are common to.
% Character codes '015 '032, '036, '037, '045 are represented.
% (Actually the accents in positions '025, '026, '031, '032 are
% not generated unless ligs ≠ 0, since other symbols are substituted
% for those accents in non-ligature fonts )

"Grave accent";
call charbegin('015, 9, 0, 0, ph, 0, 2/3[ph, px] slant + 5pw − pwi/6 − 19/6 pu),
cpen;   lft1x1 = round 2u;   x2 = 1/3[x1, r − x1],
top1y1 = h,   y2 = 2/3[h, m];
call 'a cdraw(1, 2, 1, 0).                                    % diagonal

"Acute accent",
call charbegin('016, 9, 0, 0, ph, 0, ph slant − 1.5pu),
cpen,   rt1x1 = round(r − 2u);   x2 = 2/3[x1, r − x1],
top1y1 = h;   y2 = 1/3[h, m];
call 'a cdraw(1, 2, 1, 0).                                    % diagonal

"Circumflex (hat) accent";
call charbegin('017, 9, 0, 0, ph, 0, 5[px, ph] slant + 5pw − 2pu);
x1 = good0 2 5u,   x2 = x4 = r − x2,   x3 = r − x1,          % left-right symmetry
vpen,   y1 = y3 = 5[m, y0];   top8y0 = top0y2 = h,   bot8y0 = bot0y4,
w3 ddraw 2 . 1, 4 . . 1;                                      % left point
ddraw 2 . 3, 4   3.                                            % right point

"Hachek (hooklet) accent";
call charbegin('020, 9, 0, 0, .75[px, ph], 0, 75[px, ph] slant + .5pw − 2pu),
x1 = good0 2 5u,   x2 = x4 = r − x2,   x3 = r − x1,           % left-right symmetry,
vpen;   top0y1 = round .75[m, h],   y1 = y3;
top8y20 = h,   y21 = .5[m, y20],   y1 − y0 = y20 − y21,         % inverted circumflex
top8y0 = top0y1;   bot8y0 = bot0y2;
w3, ddraw 2   1, 4 .  1;                                      % left point
ddraw 2 . . 3, 4 .  3                                          % right point

"Breve accent";
call charbegin('021, 9, 0, 0, ph, 0, ph slant + 5pw   1 5pu),
x0 = x1 = good0 2u,   x3 = r − x2,   x4 = x1 = r − x1,         % left-right symmetry
new w99,   w99 = round 25[w3, w8],
y0 = y1 = 1 25[m, h],   y3 = y1,   y2 = 1/3[m, h],
vpen,   top99y1 = h,
draw |w99#|2{−1, 0} . . |w3#|1( . 0);                          % left point
draw |w99#|2{1, 0} . . |w3#|3( . . 4).                          % right point
```



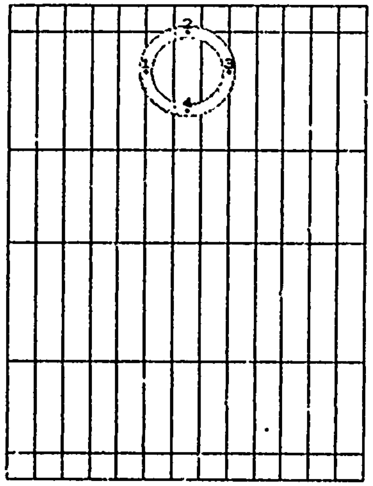


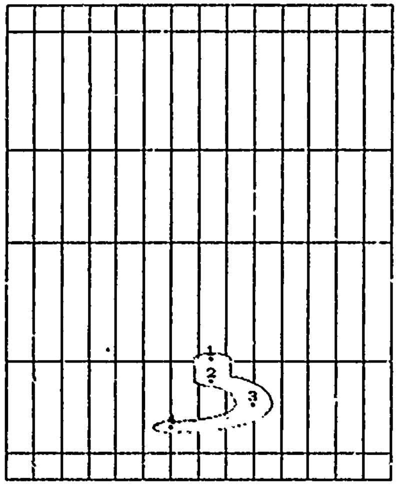


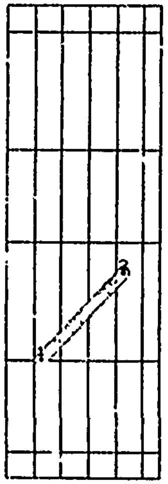


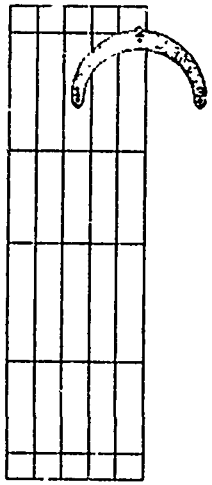


```
"Macron (bar) accent",
call charbegin('022, 9, 0, 0, 1/3[px, ph] + prt aspect, 0, 1/3[px, ph] slant + 5pw - 1 5pu),
x1 = good0 2u;   x2 = r - x1,   y1 = y2,
vpen,   new w90;   w90 = round 25[w6, w8],   bot90y1 = 1/3[m, h],
w90 draw 1 . 2                                                        % bar

"Umlaut (double dot) accent";
call charbegin('023, 9 0, 0, ph, 0, ph slant + 5pwu - 2pu);
x1 = good3 2 5u;   x2 = r - x1;   y1 = y2,
cpen,   top3y1 = h,
w3 draw 1;                                                            % left dot
draw 2.                                                               % right dot

"Tilde (squiggle) accent";
call charbegin('024, 9, 0, 0, ph, 0, ph slant + 5pwt - 1 5pu);
x1 = 2u,   x4 = r - 2u,   x2 = 25[x1, x4],   x3 = 75[x1, x4],
new aa, bb, rr, costh, sinth;
aa = 1/3(x4 - x1),   bb = 2(h - m);   rr = sqrt(aa·aa + bb·bb),
costh = aa/rr;   sinth = bb/rr;
spen(4(costh costh/w1/w1 + sinth sinth/w0/w0),
     8costh sinth(1/w1/w1 - 1/w0/w0),
     4(costh costh/w0/w0 + sinth sinth/w1/w1),
     0, 0, 0, 0);                         % oblique pen in direction {(x4   x1)/3, y2 - y1}
top0y1 = 8[m, h];   top0y2 = h,   y3 = y1;   y4 = y2,
w0 draw 1 . 2{1, 0} . 3{1, 0} . . 4.                                  % points and stroke

if ligs ≠ 0    "Arrow (vector) accent",
     call charbegin('025, 9, 0, 0  75[px, ph] + prt aspect/2, 0, 5[px, ph]slant),
     cpen,   lft10x1 = round 5u   x2 = r - x1;   y1 = y2 -  5[m, h],
     w10 draw 1   2;                                                  % bar
     rt10x3 = round(x2 - u);   x4 = x3,
     y3 = y2 + (h - m)/4,   y4 = y2 - (h - m)/4,
     draw 3{ 5(x2 - x1), y2 - y3}   2{x2 - x1, 5(y2 - y1)},           % upper point
     draw 4{ 5(x2 - x1), y2 - y4}   2{x2 - x1, 5(y2 - y4)};           % lower point
fi.

if ligs ≠ 0    "Long Hungarian umlaut accent",
     call charbegin('026, 9, 0, 0, ph, 0, ph slant - pu),
     cpen,   x1 = good0 2 5u,   rt1x2 = round 5r,
     x3 - x1 = x4 - x2;   rt1x4 = round(r - 1 5u),
     y1 = y3 - 1/3[m, h],   top1y2 = h,   y2 = y4,
     call `a cdraw(2, 1, 1, 0),                                       % left diagonal
     call `b cdraw(4, 3, 1, 0),                                       % right diagonal
fi.
```

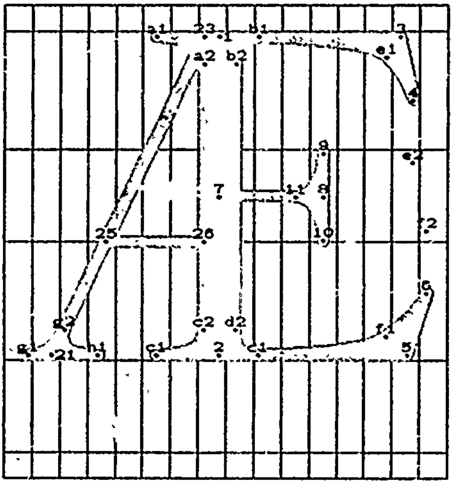




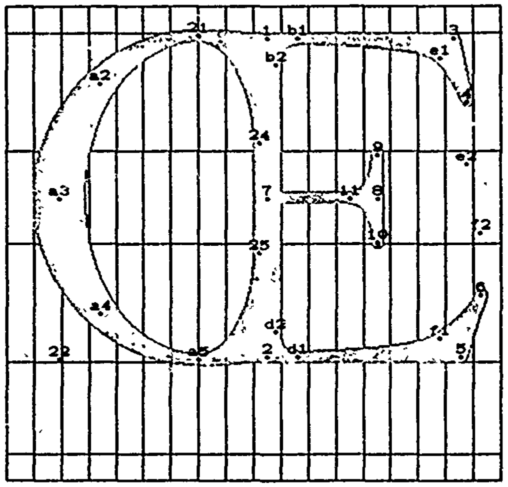




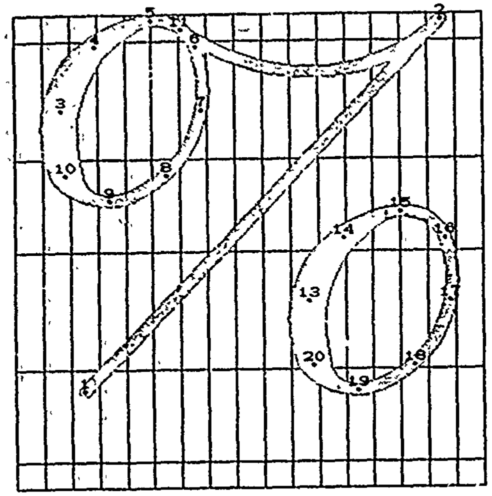
```
"Scandinavian circle accent";
% This character is designed to be used as an ordinary accent on an 'a'
% or to be raised 2/3(ph − px) points and superimposed on an 'A'
call charbegin('027, 13, 0, 0, ph, 0, 0),
x1 = good0 5u;   x2 = x1 = r − x2,   x1 = r − x1;
hpen,   top0y2 = h + o;   top0y1 = round 1/4[m,h] + o,   y1 = y1 = 5[y2, y1];
w0 draw 4{−1,0} . 1{0,1} . 2{1,0};                                  % left half of bowl
draw 4{1,0} . . 3{0,1}   2{−1,0}.                                   % right half of bowl

"Cedilla accent";
% This character is designed to be used as an ordinary accent on a 'c'
% or to be superimposed on a 'C'.
call charbegin('030, 14, 0, 0, 0, .75pd, 0);
x1 = x2 = 7 5u,   x1 = x2 + 1 5u,   x1 = x2 - 1.5u,
new w99,   w99 = round 5[w0, w1];
hpen,   bot1y1 = −oo;   bot1y2 = round(− 25d − oo),
w1 draw 1 . . 2;                                                    % stem
bot1y1 = round(− 75d − oo);   y. = 5[y2, y1];
draw 2{1,0}   3{0,−1}   4{   1,0}                                   % hook

if ligs ≠ 0   "Cross for Polish l and L";
% This character is designed to be used as an ordinary accent on an 'l'
% or to be raised ph − px points and superimposed on an 'L'
     call charbegin('031, 4 + pwiv/pu, 2sc, 2sc, px − (ph − px), 0, 0),
     lft1 .5[x1, x2] = 2u,   x2 − x1 = 3u;
     top0y2 + (h − m) = m;   y1 + (h − m) = e,
     w0 draw 1 . 2,                                                 % diagenal
fi.

if ligs ≠ 0:   "Tie accent",
% This character is tuned to work best with a dotless roman i
     call charbegin('032, 5, sc, sc, ph, 0, px slant + 5pwi + (sc − 2)pu);
     x1 = good0 .5r,   y1 = y1 − 1/3[m,h],   x2 = 5[x1, x1],   x1 = good0(r + 2u),
     vpen,   top10y2 = h + oo;
     w10 draw 1{0,1} . 2{1,0},                                      % left point
     draw 3{0,1}   2{− 1,0};                                        % right point
fi.
```

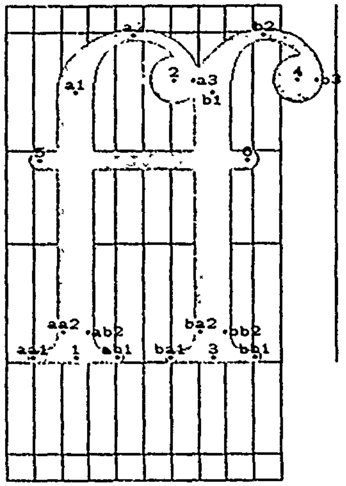


```
"Upper case ligature AE";
call charbegin('036, 16, 2sc, sc, ph, 0, armic);
hpen;
lft1x1 = round 7u,   x2 = x1;   top1y1 = h,   bot1y2 = 0;
w1 draw 1..2;                                              % stem
if ucs ≠ 0:
     call 'a serif(1, 4, 2, −ucs);
     call 'b serif(1, 4, 2, 5ucs);                         % upper stem serif
     call 'c serif(2, 4, 1, −ucs);
     call 'd serif(2, 4, 1, 5ucs);                         % lower stem serif
fi;
new ss;   ss = 1.4aspect ucs·u + eps;
if ss + w0 > .25h:   new ss;   ss = .25h − w0 + eps;
fi;
rt0x3 = round(r − 1.5u);   x4 = x3 + .5u;   y3 = y1;   y4 = y3 − ss;
rt0x5 = round(r − 1.25u);   x6 = x5 + .5u,   y5 = y2,   y6 = y5 + ss,
call 'e arm(1, 3, 4);                                      % upper arm and serif
call 'f arm(2, 5, 6);                                      % lower arm and serif
x7 = x1;   y7 = y8 = .5[y1, y2];   x8 = good0 11.5u;
w0 draw 7..8;                                              % middle arm
if ucs ≠ 0.   x9 = x10 = x8;   y9 = y8 + .7ss,   y10 = y8 − .7ss,
     if w0 = w1:   w0 draw 9..10;                          % middle arm serif
     else:   x11 = x8 − u;   y11 = y8;
          minvr 0;   minvs 0;
          w0 ddraw 11{ , }..10{0, −1}, 8..10;
          ddraw 11{1, 0}..9{0, 1}, 8..9;                   % middle arm serif
          minvr .5,   minvs .5;
     fi;
fi;
lft0x21 = round 1.5u;   bot0y21 = 0;   lft0x21 = lft1x1,   top0y21 = h;
w0 draw 23..21;                                            % left diagonal stroke
y25 = y26 = e;
x25 − 1 = (y25 − y21)/(y23 − y21)[x21, x23],   x26 = x23,
w0 draw 25..26,                                            % bar line
if ucs ≠ 0.   call 'g serif(21, 0, 23, −.5ucs);
     call 'h serif(2i, 0, 23, ucs);                        % left serif
fi.
```



```
"Upper case ligature OE";
call charbegin('037, 18, 0, sc, ph, 0, armic);
hpen;   new w99;   w99 = round .5[w0, w1];
lft99x1 = round 9u;   x2 = x1;   top99y1 = h;   bot99y2 = 0;
w99 draw 1..2;                                                          % stem
if ucs ≠ 0:
     call `b serif(1, 99, 2, .5ucs);                       % upper stem serif
     call `d serif(2, 99, 1, .5ucs);                       % lower stem serif
fi;
new ss;   ss = 1.4aspect·ucs·u + eps;
if ss + w0 > .25h:   new ss;   ss = .25h − w0 + eps;
fi;
rt0x3 = round(r − 1.5u);   x4 = x3 + .5u;   y3 = y1;   y4 = y3 − ss;
rt0x5 = round(r − 1.25u);   x6 = x5 + .5u;   y5 = y2;   y6 = y5 + ss;
call `e arm(1, 3, 4);                                  % upper arm and serif
call `f arm(2, 5, 6);                                  % lower arm and serif
x7 = x1;   y7 = y8 = .5[y1, y2];   x8 = good0 13.5u;
w0 draw 7..8;                                                     % middle arm
if ucs ≠ 0:   x9 = x10 = x8;   y9 = y8 + .7ss,   y10 = y8 − .7ss;
     if w0 = w1:   w0 draw 9..10;                           % middle arm serif
     else:   x11 = x8 − u;   y11 = y8;
          minvr 0;   minvs 0;
          w0 ddraw 11{1,0}   10{0,−1}, 8..10;
          ddraw 11{1,0}..9{0,1}, 8..9;                      % middle arm serif
          minvr 5;   minvs .5;
     fi;
fi;
if fixwidth ≠ 0:   new save,   save = sqrttwo;
     new sqrttwo;   sqrttwo = sqrt save;                  % super-superellipse
     lft5x22 = round 1.5u;
else:   lft5x22 = round u;
fi;
x21 = 7u;   top0y21 = h + oo;   bot0y22 = −oo;
call `a darc(21, 22, w5);                                  % left part of bowl
x23 = x21;   y23 = y22;
lft0x24 = lft99x1;   x24 = x25;   y24 = 2/3h;   y25 = 1/3h;
w0 draw 21{1,0}  .24{0,−1};                         % upper right part of bowl
draw 23{1,0}..25{0,1};                              % lower right part of bowl
if ucs ≠ 0:   if w0 ≠ w1:
     ddraw 21{1,0}   24{0,−1}, 21{1,0}.  1{1,0};                  % fill in
     ddraw 23{1,0}.  25{0,1}, 23{1,0}.  2{1,0};                   % fill in
     fi;
fi;
if fixwidth ≠ 0:   new sqrttwo;   sqrttwo = save;
fi.
```

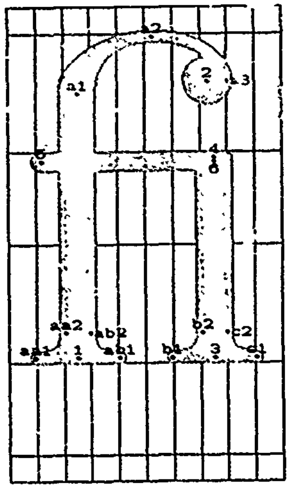


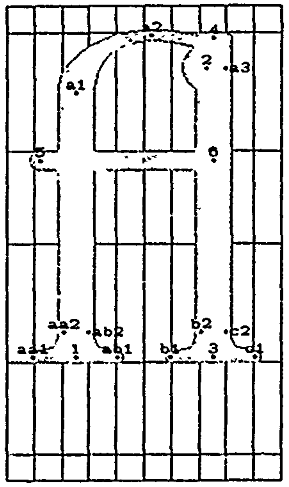


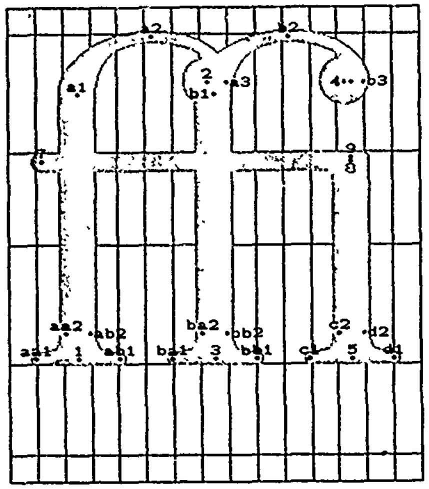
```
"Per cent sign";
call charbegin('045, 17, 0, 0, ph + pb, pb, (ph + pb)·slant + 5pw − pu);
hpen;  x_1 = 2.5u;  x_2 = r − 1.5u;  bot_0 y_1 = −b,  top_0 y_2 = h + b;
w_0 draw 1..2;                                                   % diagonal
lft_1 x_3 = round u;  rt_0 x_7 = round .5(r − 3u);
new ss, st;  ss = .25(x_2 − x_1)/(y_2 − y_1);       % reciprocal slope for ellipses
y_3 = y_7 = .5[y_5, y_9];  top_0 y_5 = h + b;  bot_0 y_9 = round .5h;
st = 1/(sqrt 2);  y_4 = y_6 = st[y_9, y_5];  y_8 = y_10 = st[y_5, y_9];
ss(y_5 − y_9) = x_5 − x_9;  ss(y_4 − y_10) = x_4 − x_10 = x_6 − x_8;
x_37 = .5[x_3, x_7] = .5[x_5, x_9];  5[x_4, x_10] = st[x_37, x_3],  5[x_6, x_8] = st[x_37, x_7];
draw |w_1#|3{ss, 1} .|5/6[w_0, w_1]|4{x_5 − x_3 + ss(y_5 − y_3), y_5 − y_3}.
     |w_0#|5{1, 0}..6{x_7 − x_5 + ss(y_7 − y_5), y_7 − y_5}..7{−ss, −1}..
     8{x_9 − x_7 + ss(y_9 − y_7), y_9 − y_7}..9{−1, 0}..
     |5/6[w_0, w_1]|10{x_3 − x_9 + ss(y_3 − y_9), y_3 − y_9}  |w_1#|3{ss, 1},    % upper bowl
y_11 = .9[y_7, y_5];  x_11 = (sqrt(1 − (.9)(.9)))[x_37, x_7] + ss(y_11 − y_7);   % point on ellipse
y_12 = .901[y_7, y_5];  x_12 = (sqrt(1 − (.901)(.901)))[x_37, x_7] + ss(y_12 − y_7),   % nearby point
w_0 draw (12..)11..2{x_2 − x_1, y_2 − y_1};                                   % link
x_13 − x_3 = x_14 − x_4 = x_15 − x_5 = x_16 − x_6 = x_17 − x_7 =
     x_18 − x_8 = x_19 − x_9 = x_20 − x_10 = round .5(r + u);
y_13 − y_3 = y_14 − y_4 = y_15 − y_5 = y_16 − y_6 = y_17 − y_7 = y_18 − y_8 = y_19 − y_9 = y_20 − y_10,
bot_0 y_19 = −b;
draw |w_1#|13{ss, 1}..|5/6[w_0, w_1]|14{x_5 − x_3 + ss(y_5 − y_3), y_5 − y_3}..
     |w_0#|15{1, 0}. 16{x_7 − x_5 + ss(y_7 − y_5), y_7 − y_5}. 17{−ss, −1}..
     18{x_9 − x_7 + ss(y_9 − y_7), y_9 − y_7}..19{−1, 0}..
     |5/6[w_0, w_1]|20{x_3 − x_9 + ss(y_3 − y_9), y_3 − y_9}. |w_1#|13{ss, 1}       % lower bowl
```

The file romlig.mf

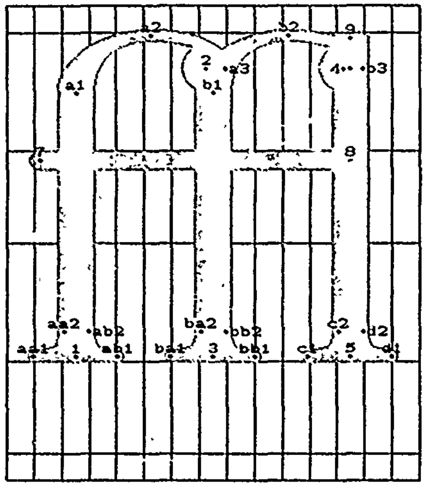
```
"The ligature ff";
call charbegin('173, 10, 0, 0, ph, 0, ph slant + 2pu);
hpen,  x_1 = good_1 2 5u;  x_3 = good_1(r − 2.5u);
if w_0 = w_1:  rt_3 x_2 = round 6.5u,  x_1 − x_3 = x_2 − x_4;
else:  rt_3 x_2 = round(.5r + 2u);  rt_3 x_4 = round(r + 1 5u);
fi,
cpen;  top_3 y_2 = .8[m, h];  y_4 = y_2;
call `a fstroke(2, 1);                      % left bulb, shoulder, stem, and serif
call `b fstroke(4, 3);                      % right bulb, shoulder stem and serif
lft_10 x_5 = lft_1 x_1 − u − eps,  rt_10 x_6 = rt_1 x_3 + u + eps,  top_10 y_5 = m,  y_6 = y_5
w_10 draw 5..6.                                                        % bar link

lig `f:  `i = '174, `f = '173, `l = '175;
```



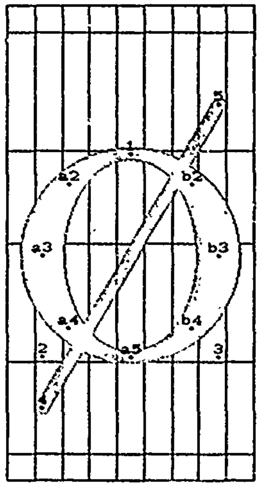


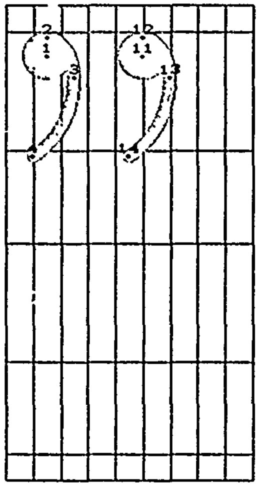


```
 The ligature fi";
call charbegin('174, 10, 0, 2sc, ph, 0, ph·slant + 5pwi + (2sc − 2)pu);
hpen;   x1 = good1 2.5u;   x3 = x4 = good1(r − 2.5u);
rt1x2 = rt1x1;
cpen;   top3y2 = .8[m, h];
call `a fstroke(2, 1);                                    % bulb, shoulder, left stem, left serif
hpen;   top0y1 = m;   bot0y3 = 0;   w1 draw 3..4;                                  % right stem
cpen;   lft10x5 = lft1x1 − u − eps;   x6 = x3;   top10y5 = m;   y6 = y5;
w10 draw 5..6;                                                                     % bar link
if lcs ≠ 0:   call `b serif(3, 1, 4, − lcs);
      call `c serif(3, 1, 4, lcs);                                                 % right serif
fi.                                                          % appropriate end to "fi"

"The ligature fl";
call charbegin('175, 10, 0, 2sc, ph, 0, ph·slant + .5pwi + (2sc − 2)pu);
hpen,   x1 = good1 2.5u;   x3 = x4 = good1(r − 2.5u);
rt3x2 = rt1x3;
cpen;   top3y2 = .9[m, h];
call `a fstroke(2, 1);                                    % bulb, shoulder, left stem, left serif
hpen;   top0y1 = h;   bot0y3 = 0;   w1 draw 3 .4;                                  % right stem
cpen;   lft10x5 = lft1x1 − u − eps,   x6 = x3;   top10y5 = m;   y6 = y5;
w10 draw 5. 6;                                                                     % bar link
if lcs ≠ 0:   call `b serif(3, 1, 4, −lcs);
      call `c serif(3, 1, 4, lcs);                                                 % right serif
fi.

"The ligature ffi";
call charbegin('176, 15, 0, 2sc, ph, 0, ph·slant + 5pwi + (2sc − 2)pu);
hpen;   x1 = good1 2.5u,   x4 = good1 .5r;
x5 − x3 = x1 − x2 = x3 − x4,   x6 = x5 = x9;   y2 = y4 = y6;
cpen;   top3y2 = .8[m, h];   rt1x4 = rt1x6;
call `a fstroke(2, 1);                                % left bulb, shoulder, stem, and serif
call `b fstroke(4, 3);                     % right bulb and shoulder, middle stem and serif
hpen;   top0y9 = m;   bot0y5 = 0;   w1 draw 5..9;                                  % right stem
cpen;   lft10x7 = lft1x1 − u − eps;   x8 = x5;   top10y7 = m;   y8 = y7;
w10 draw 7..8;                                                                     % bar link
if lcs ≠ 0·   call `c serif(5, 1, 6, −lcs);
      call `d serif(5, 1, 6, lcs);                                                 % right serif
fi.

lig '173:   `1 = '176, `1 ← '177,
```



6

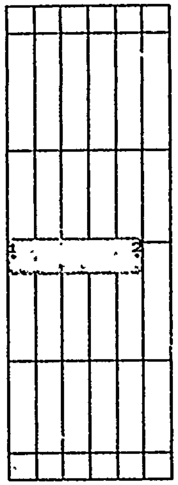


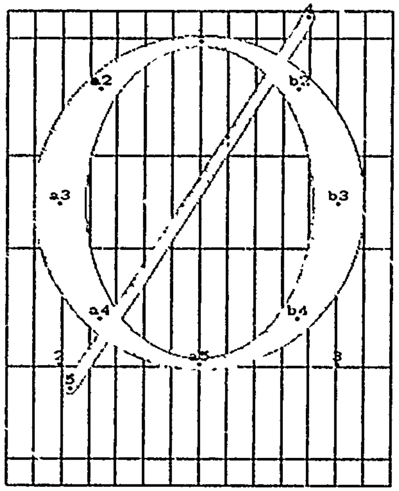


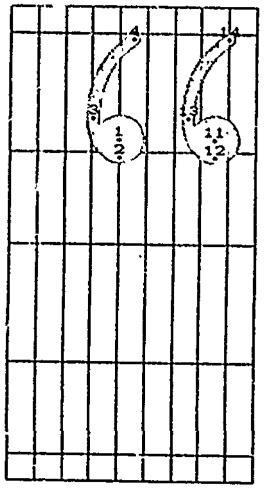
```
"The ligature ffl";
call charbegin('177, 15, 0, 2sc, ph, 0, ph slant + .5pwi + (2sc — 2)pu),
hpen;   x1 = good1 2.5u,   x3 = good1 .5r;
x5 — x3 = x1 — x2 = x3 — x1;   x6 = x5 = 29,   y2 = y1 = y6,
cpen;   top3y2 = .9[m,h];   rt3x1 = rt1x6;
call `a fstroke(2, 1);                                  % left bulb, shoulder, stem, and serif
call `b fstroke(4, 3);                     % right bu'b and shoulder, middle stem and serif
hpen;   top0y9 = h;   bot0y5 = 0;   w1 draw 5..9;                                % right stem
cpen;   lft10x7 = lft1x1 — u — eps;   x8 = x5;   top10y7 = m,   y8 = y7;
w10 draw 7. 8,                                                                   % bar link
if lcs ≠ 0:   call `c serif(5, 1, 6, —lcs);
     call `d serif(5, 1, 6, lcs);                                               % right serif
fi.
```

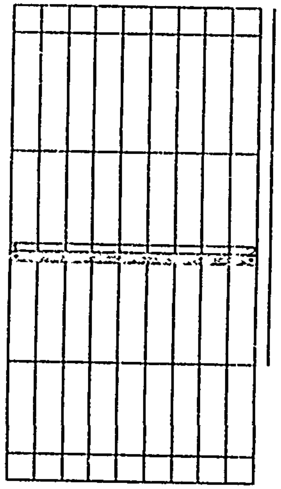
The file romitl mf

```
% This file defines characters common to roman and italic text fonts
% that do not appear in non-ligature fonts.
% Character codes '040, '042, '055, '100, '134, '136, '137 are used.

"The Scandinavian letter o-slash";
call charbegin('040, 9, 0, 0, px + .5pd, .5pd, (px + .5pd)·slant + 5(pw — pwii));
hpen;   x1 = r — x1;                                         % axis of left-right symmetry
if fixwidth = 0:   lft2x2 = round .5u;
else:   lft2x2 = round 1.5u;
fi;
x1 — x2 = x3 — x1;   top0y1 = m + oo;   bot0y2 = —00;   y2 = y3,
call `a darc(1, 2, w2);                                                  % left part of bowl
call `b darc(1, 3, w2);                                                 % right part of bowl
x4 = x2;   x5 = x1,   y4 = — 5d;   y5 = m + 5d;
w0 draw 4..5.                                                                    % diagonal

"Closing quotes";
call charbegin('042, 9, 0, 0, ph, 0, 2/3[px, ph]·slant + 5pw — 2.5pu),
% There is rotational symmetry with respect to opening quotes
cpen;   top3y1 = top6y2 = h;   top6y1 = m,   y4 = 1/3[y1, y2],
x1 = x2 = good3 1.5u,   x3 = good0(x1 + u + eps);   x4 = x1 — 5u — eps;
x11 — x1 = x12 — x2 = x13 — x3 = x14 — x4 = round 3 5u;
y11 = y1;   y12 = y2;   y13 = y3;   y14 = y4;
w3 draw 1;                                                                      % left bulb
draw 11;                                                                       % right bulb
hpen;   w0 draw 2{1, 0}..3{0, —1}. 4{3(x4 — x3). y4 — y3};                        % left tail
draw 12{1, 0}..13{0, —1}..14{3(x14 — x13), y14 — y13}.                          % right tail

lig ``:   `` = '042;
```

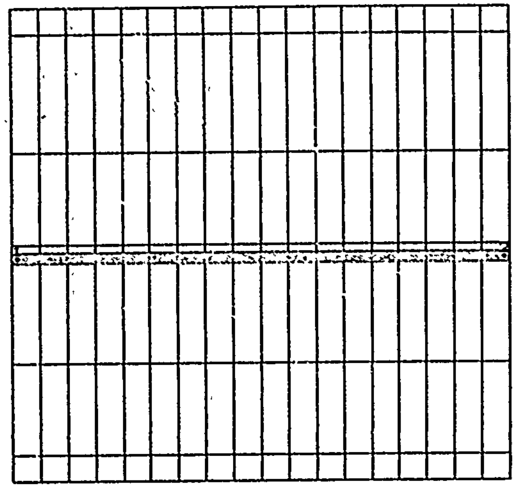


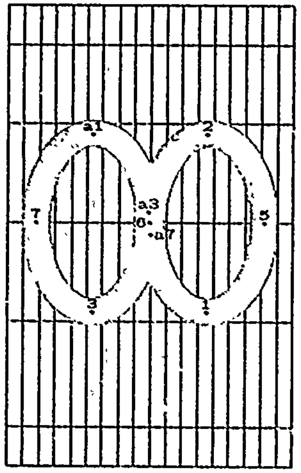


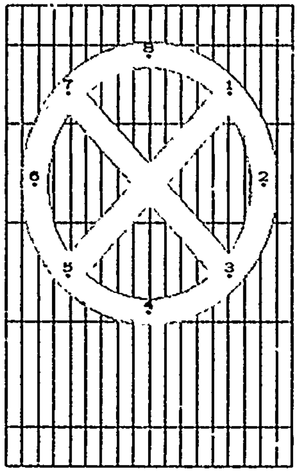




```
"Hyphen";
call charbegin('055, fixwidth[6, 9], 0, 0, px, 0, .5px·slant — .5pu);
vpen;   y1 = y2 = .5m;
if fixwidth = 0    lft7x1 = 0;   rt7x2 = r — u;
else.   lft7x1 = 1.5u,   x2 = r — x1;
fi;
w7 draw 1  .2.                                                        % bar

"The Scandinavian letter O-slash";
call charbegin('100, 14, 0, 0, ph + pb, pb, 5ph slant — .5pu),
hpen;
if fixwidth ≠ 0·   new save,   save = sqrttwo;
     new sqrttwo;   sqrttwo = sqrt save,                 % super-superellipse
     lft7x2 = round 1 5u;
else·   lft7x2 = round u;
fi;
x1 = r — x1;                                        % axis of left-right symmetry
top0y1 = h + oo,
bot0y2 = —oo;   y1 = y2,   x1 = r — x2,
call 'a darc(1, 2, w5),                                 % left part of bowl
call 'b darc(1, 3, w5),                                 % right part of bowl
if fixwidth ≠ 0:   new sqrttwo,   sqrttwo - save,
fi;
top0y4 = h + b,   bot0y5 = —b;   rt0x4 = lft7x3,   lft0x5 = rt0x2,
w0 draw 4  .5;                                                        % diagonal
fi.

"Opening quotes";
call charbegin('134, 9, 0, 0, ph, 0, ph·slant + 5pw — 5pu),
% There is rota'ional symmetry with respect to closing quotes
cpen;   bot3y1 = bot0y2;   top0y4 = h,   y3 = ½[y1, y2];   y2 — y1 = m — h;
x1 = x2 = good3 4u,   x4 = good0(x1 — u — eps),   x3 = x1 + 5u + eps,
x11 — x1 = x12 — x2 = x13 — x3 = x14 — x4 = round 3 5u,
y11 = y1;   y12 = y2,   y13 = y3;   y14 = y4;
w3 draw 1;                                                        % left bulb
draw 11;                                                         % right bulb
hpen,   w0 draw 2{—1, 0}   3{0, 1}   4{3(x4 — x3), y4 — y3},            % left tail
draw 12{—1, 0}   13{0, 1}  .14{3(x14 — x13), y14   y13}                % right tail
lig '':   '' = '134;

"En dash";
call charbegin('136, 9, 0, 0, 5px + 5pw aspect, 0, 5px·slant + 5pu),
hpen;   lft0x1 = 0;   rt0x2 = r;   y1 = y2 = .5m;
w0 draw 1 . . 2.                                                        % bar
lig '-:   '- = '136;
```



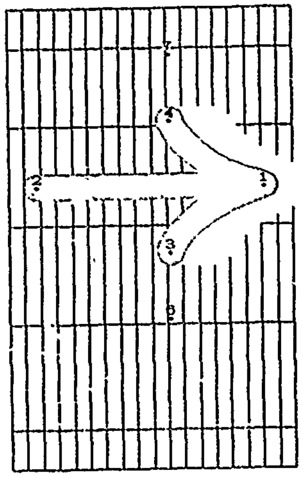


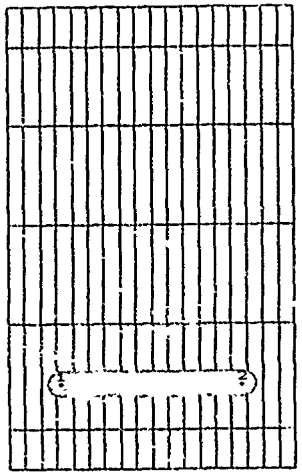


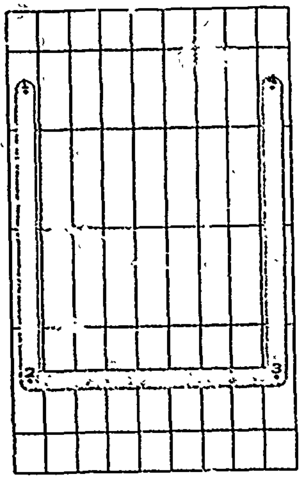
```
"Em dash";
call charbegin('137, 18, 0, 0, 5px + 5pw·aspect, 0, 5px·slant + 5pu);
hpen;   lft0x1 = 0;   rt0x2 = r;   y1 = y2 = .5m;
w0 draw 1. 2.                                                        % bar
lig '136:   `- = '137;
```

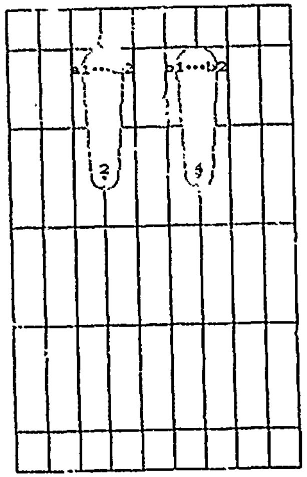
The file romits mf

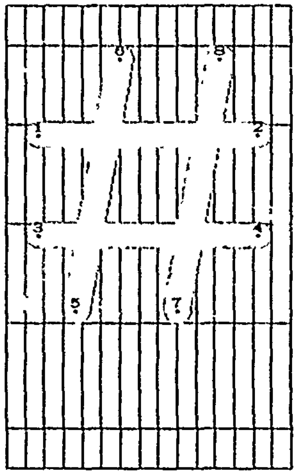
```
% This file contains the characters subst.uted into a text font when lgs = 0 is set
% Character codes '025, '026, '031, '032, '040, '042 '044, '055,
% '100, '134, '136, '137, and '173 '177 are affected
"Infinity";
call charbegin('025, 18, 0, 0, px, 0, 5px·slant — 5pu),
new w95, w99;   w99 = round .25[w0, wi],   w98 = 2[w1, w2];
vpen;   top99y2 = m + oo;   bot99y1 = —oo;   y2 = y1;   y1 = y3;
x1 = x2;   x3 = x1,   y5 = y6 = y7 = .5[y1, y2];
lft0x7 = round u;   rt0x5 = round(r — u);   x6 = .5[x7, x5];
new ss, mss;   ss = —6u/m;                               % reciprocal slope at center
if w0 = w98:   mss = ss;
else    mss = .75ss;
fi;
call `a zdraw(5, 1, 6, 4, 7, w99, w98, ss);             % lower right and upper left strokes
w99 draw 5{0, 1}..2{— 1, 0}   6{mss, —1}
     3{—1, 0}..7{0, 1}.                                  % upper right and lower left strokes

"Circle-times operator";
call charbegin('026, 18, 0, 0, ph, ph - 2pa, pa·slant -- 5pu),
cpen,   lft0x6 = round u;   y8 = a,   x5 = r — x6,   top0y8 — h + oo;
call circle(1, 2, 3, 4, 5, 6, 7, 8, w0);                                  % bowl
w0 draw 7..3;                                        % upper left to lower right diagonal
draw 5..1.                                           % lower left to upper right diagonal
```



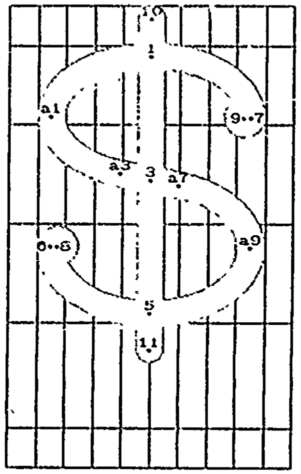


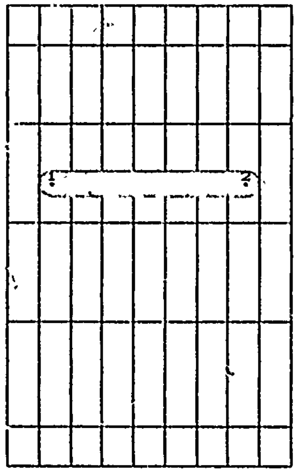


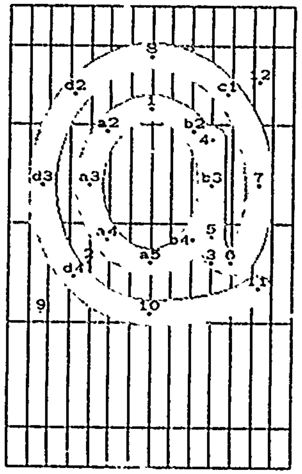




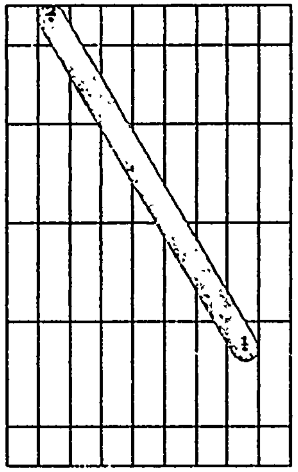
```
"Rightward arrow";
call charbegin('031, 18, 0, 0, .24ph + 5prt + pa, .24ph + 5prt − pa, pa slant − 5pu);
cpen;   lft_10 x_2 = round u,   rt_10 x_1 = x_0 = round(r − u);
y_1 = y_2 = y_5 = y_8 = good_10 a;                                        % bar
w_10 draw 1..2;
hpen;   rt_1 x_8 = x_0;
x_5 − x_8 = x_8 − x_3 = fixwidth[3u, 6u] + eps;   x_3 = x_4 = x_6 = x_7;
y_3 − y_6 = y_1 − y_3 = y_4 − y_1 = y_7 − y_4 = .24h + eps;
rpen#;   w_10 + w_1 draw (5 . )8 . 3( . .6);             % erase excess at lower right
hpen;   draw (|w_1|5 . . )8 . |w_0|3( .6);                                  % lower point
rpen#,   w_10 + w_1 draw (5 . )8 . 4( . 7);             % erase excess at upper right
hpen;   draw (|w_1|5 . . )8 . |w_0|4( .7)                                   % upper point

"Underbar suitable for < and >";
call charbegin('032, 18, 0, 0, 0, .5[px, ph] + prt/2 − 2pa + (px − pe), 0),
y_22 = good_10 .5[m, h];   .5[y_22, y_21] = good_10 a;   y_1 = y_2 = y_21 − (m − e);
cpen;   lft_10 x_1 = round 2.5u;   x_2 = r − x_1;                          % bar
w_10 draw 1..2.

"Blank-space sign";
call charbegin('040, 9, 0, 0, .5[px, ph], .5pd, .5[px, ph] slant + .25pu);
cpen,   new w_99;   w_99 = round(.75pixels pw + blacker);       % smaller than hairline
lft_99 x_1 = round .25u;   rt_99 x_4 = round(r − .25u);   x_1 = x_2,   x_3 = x_4;
y_1 = y_4 = .5[m, h];   y_2 = y_3 = good_99(−.5d);
w_99 draw 1..2..2..3..3..4.                             % left stem, bar, right stem

"Straight double quotes";
call charbegin('042, 9, 0, 0, ph, 0, ph·slant + .5pw_ii − 2.5pu);
new w_99,
if w_1 < w_0 sqrt 2:   w_99 = round w_0 sqrt 2,
else:   w_99 = w_1;
fi,
x_1 = x_2 = good_99 3u,   x_3 = x_4 = r − x_1,
cpen;   top_99 y_1 = h;   y_2 = .5[c, m];   y_3 = y_1,   y_4 = y_2,
call `a cdraw(1, 2, 99, 0);                                              % left stem
call `b cdraw(3, 4, 99, 0)                                              % right stem

"Sharp symbol (number sign or hash mark)";
call charbegin('043, 15, 0, 0, ph, ph − 2pa, 0);
cpen,   lft_10 x_1 = round u;   x_3 = x_1;   x_2 = x_4 = r − x_1;
y_1 = y_2,   y_3 = y_4;   y_1 − y_3 = round(m − c),   .5[y_1, y_3] = a,
w_10 draw 1..2;                                                          % upper bar
draw 3..4;                                                               % lower bar
x_5 − 2u = x_1;   x_8 + 2u = x_2,   x_6 − x_5 = x_8 − x_7;   x_6 − x_7 = fixwidth[0, −3u],
y_5 = y_7;   y_6 = y_8;   top_10 y_6 = h;   .5[y_5, y_6] = a;
draw 5..6;                                                          % left diagonal
draw 7..8.                                                         % right diagonal
```

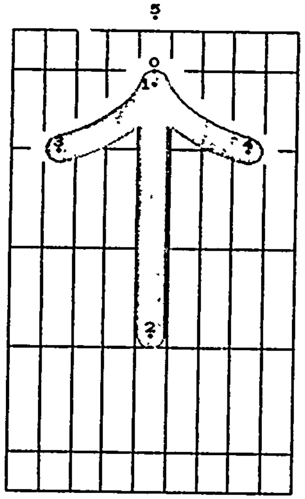


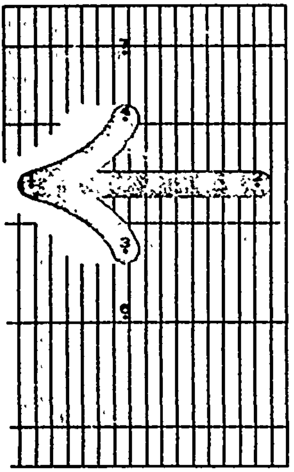


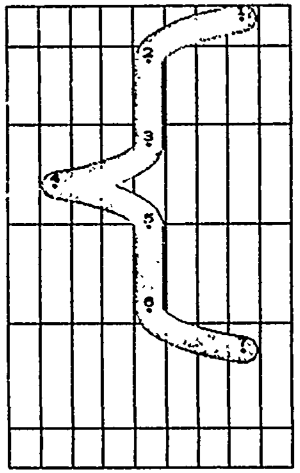


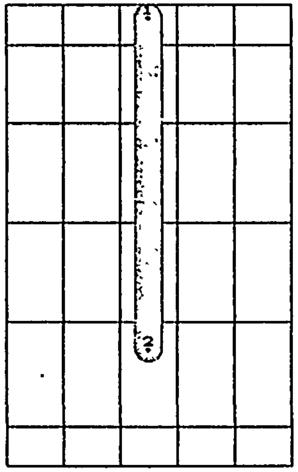
```
"Dollar sign";
call charbegin('044, 10, 6, 0, ph + pb, pb, ph·slant — .5pu),
hpen;   top0y1 = h + oo,   bot0y5 = —oo;
x1 = good10.5r;   y3 = .52h;   lft11x2 = round u,   x4 = r — x2;
if ucs = 0:   x1 = x5 = x3;   y6 = 5[y5, y3];   y7 = .5[y1, y3];
else.   if w6 = w5:   x1 = x5 = x3,   y6 = 5[y5, y3];   y7 = 5[y1, y3],
     else:   x1 + .5u = x5 — 5u = x3;   y6 = h/4 — 1,   y7 = 8h + 1,
     fi;
fi;
y8 = y6;   y9 = y7;   cpen;   lft3x8 = lft0x6;   rt3x9 = rt0x7,   x6 = x2,   x7 = x4,
w1 draw 8;                                                        % lower bulb
draw 9;                                                           % upper bulb
hpen;   w0 draw 6{0, —1}   5{1, 0};                          % lower left stroke
draw 7{0, 1}   1{—1, 0};                                     % upper right stroke
call `a sdraw(1, 2, 3, 4, 5, w11, w0, —h/(50u));                 % middle stroke
cpen;   x10 = x11 = x3;   top10y10 = h + b,   bot10y11 = —b;
w10 draw 10..11.                                                       % stem

"Minus sign";
cpen;
if fixwidth = 0:   if pa + 8pu > ph:
          call charbeg'n('055, 18, 0, 0, ph, ph — 2pa, pa slant — .5pu);
     else·   call charbegin('055, 18, 0, 0, 8pu + pa, 8pu — pa, pa·slant —  5pu);
     fi;
else:   call charbegin('055, 9, 0, 0, 3 5pu + pa, 3.5pu — pa, 0);
fi;
lft10x1 = round u;   x2 = r — x1,   y1 = y2 = a,
w10 draw 1. 2.                                                          % bar

"At sign";
call charbegin('100, 14, 0, 0, ph, 0, 5ph·slant +  5pw —  5pu),
hpen;   x1 = x5 = x10 = .5r,   x2 = good1 4u,   x4 = x3 = x6 = r — x2,
lft0x9 = round u;   x7 = x11 = x12 = r — x9,   x6 = 7/12[x5, x7],
top0y8 = h + oo;   bot0y10 = —oo;   y9 = y10;
y1 = good6.8[y10, y8];   y2 = y3 = y6 = good6.2[y10, y8];
y7 = .5[y10, y8];   y11 = good6.1[y10, y8];   y12 = 9[y10, y8];
y4 = 8[y2, y1],   y5 = 2/3[y7, y6];
call `a darc(1, 2, w1);                               % left part of inner bowl
call `b darc(1, 3, w0);                              % right part of inner bowl
draw |w1|4..|w1#|5{0, —1}   |w0#|6{1, 0}   7{0, 1};          % stem and link
call `c arc(8, 7, w0);                               % right part of outer bowl
call `d darc(8, 9, w0);                               % left part of outer bowl
w0 draw 10{1, 0}..11(..12,.                                         % point
```



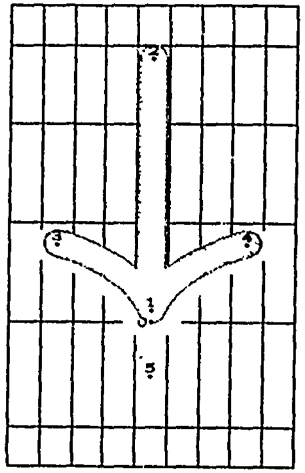


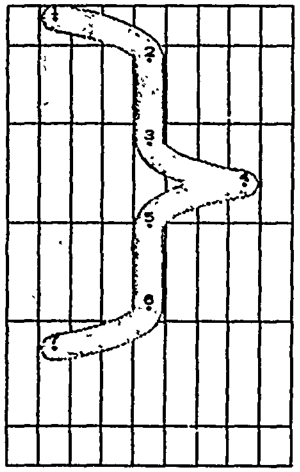


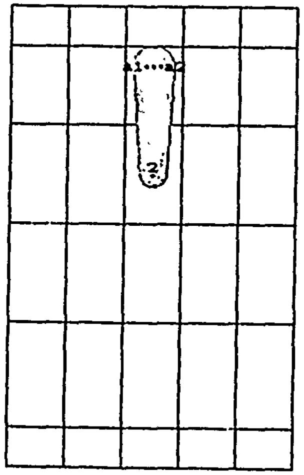




```
'Reverse slash";
call charbegin('134, 9, 0, 0, ph + pb, ph + pb — 2pa, 0);
cpen;   lft10x2 = round u;   x2 = r — x1;
top10y2 = h + b;   .5[y1, y2] = a;
w10 draw 1 .2.                                                        % diagonal

"Upward arrow";
call charbegin('136, 9, 0, 0, ph, ph — 2pa, .75ph·slant + .5pw — pu);
cpen;   top10y1 = y0 = h,   .5[y1, y2] = a;
x0 = x1 = x2 = x5 = x8 = good10.5r;
w10 draw 1..2;                                                        % stem
vpen;   top7y8 = y0;
lpen#;   w10 draw 0..8;   rpen#;   w10 draw 0..8;                     % clean the top
y5 — y8 = y8 — y3 = .24h + eps;   y3 = y4 = y6 = y7;
x3 — x0 = x1 — x3 = x1 — x1 = x7 — x1 = 3u + eps;
lpen#;   w10 draw (5..)8..3(..6);                                      % erase excess at left
vpen;   draw (|w7|5..)8..|w6|3(..6);                                  % left point
rpen#;   w10 draw (5..)8..4(..7);                                      % erase excess at right
vpen;   draw (|w7|5..)8..|w6|4(..7).                                  % right point

"Leftward arrow";
call charbegin('137, 18, 0, 0, .24ph + ˜, : ˪ pa, .24ph + .5prt — pa, pa slant — .5pu);
cpen;   lft10x1 = x0 = round u;   r 10x2 = round(r — u);
y1 = y2 = y5 = y8 = good10a;
w10 draw 1..2;                                                        % bar
hpen;   lft1x8 = x0;
x5 — x8 = x8 — x3 = —fixwidth[3u, 6u] — eps;   x3 = x1 = x6 = x7;
y3 — y6 = y1 — y3 = y. — y1 = y7 — y1 = 24h + eps;
lpen#;   w10 + w1 draw (5..)8..3(..6);                                 % erase excess at lower left
hpen;   draw (|w1|5 .)8..|w0|3(..6);                                  % lower point
lpen#;   w10 + w1 draw (5..)8..4(..7);                                 % erase excess at upper left
hpen;   draw (|w1|5..)8..|w0|4(..7).                                  % upper point

"Left brace";
call charbegin('173, 9, 0, 0, ph + pb, ph + pb — 2pa, (ph + pb)·slant + .5pw — pu);
hpen;   x2 = x1 = x5 = x6 = good1.5r;   x1 — x2 = x2 — x1 = 3u + eps;   x1 = x7;
top0y1 = h + b;   y1 = 5[y1, y..] = .5[y2, y6] = .5[y1, y5] = good0a;
y1 — y2 = y1 — y1 = (y1 — y1)/.
draw |w0#|1{3(x2 — x1), y2 — y1} .|w1#|2{0, —1}..|w1#|3{0, —1}..
     |w0#|4{3(x1 — x1), y1 — y1};                                    % upper stem
draw |w0#|7{3(x6 — x7), y6 — y7}..|w1#|6{0, 1}..|w1#|5{0, 1}.
     |w0#|4{3(x1 — x5), y1 — y5}                                     % lower stem

"Vertical line";
call charbegin('174, 5, 0, 0, ph + pb, ph + pb — 2pa, (ph + pb) slant + prt/2 — 2pu);
cpen;   x1 = x2 = good10.5r;   top10y1 = h + b;   .5[y1, y2] = a;
w10 draw 1..2.                                                        % stem
```





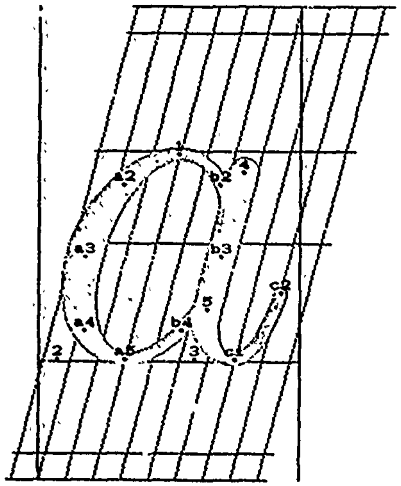


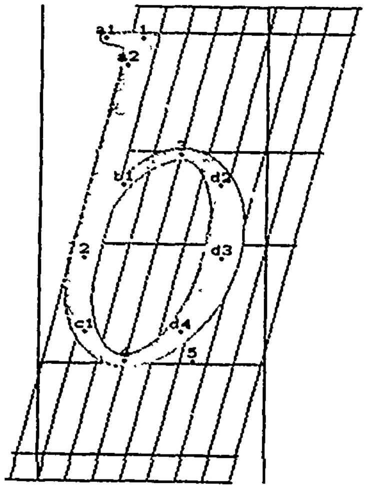
```
"Downward arrow";
call charbegin('175, 9, 0, 0, ph, ph − 2pa, 0);
cpen;   top_10 y_2 = h;   .5[y_1, y_2] = a;   y_0 = bot_10 y_1;
x_0 = x_1 = x_2 = x_5 = x_8 = good_10 .5r;
w_10 draw 1..2;                                                % stem
vpen;   bot_7 y_8 = y_0;
lpen#;   w_10 draw 0..8;   rpen#;   w_10 draw 0..8;            % clean the top
y_5 − y_8 = y_8 − y_3 = −.24h − eps;   y_3 = y_4 = y_6 = y_7;
x_3 − x_6 = x_1 − x_3 = x_4 − x_1 = x_7 − x_4 = 3u + eps;
lpen#;   w_10 draw (5..)8..3(..6);                             % erase excess at left
vpen;   draw (|w_7|5..)8..|w_0|3(..6);                         % left point
rpen#;   w_10 draw (5..)8..4(..7);                             % erase excess at right
vpen;   draw (|w_7|5..)8..|w_0|4(..7).                         % right point

"Right brace";
call charbegin('176, 9, 0, 0, ph + pb, ph + pb − 2pa, (ph + pb)·slant + .5pwi − 4pu);
hpen;   x_2 = x_4 = x_5 = x_6 = good_1 .5r;   x_1 − x_2 = x_3 − x_4 = −3u − eps;   x_1 = x_7;
top_0 y_1 = h + b;   y_4 = .5[y_1, y_7] = .5[y_2, y_6] = .5[y_3, y_5] = good_0 a;
y_1 − y_2 = y_3 − y_4 = (y_1 − y_4)/4;
draw |w_0#|1{3(x_2 − x_1), y_2 − y_1}..|w_1#|2{0, −1}..|w_1#|3{0, −1}..
     |w_0#|4{3(x_4 − x_3), y_4 − y_3};                         % upper stem
draw |w_0#|7{3(x_6 − x_7), y_6 − y_7}..|w_1#|6{0, 1}..|w_1#|5{0, 1}..
     |w_0#|4{3(x_4 − x_5), y_4 − y_5}.                         % lower stem

"Straight single quote";
call charbegin('177, 5, 0, 0, ph, 0, 0);
new w_99;
if w_3 < w_0 sqrt 2:   w_99 = round w_0 sqrt 2;
else:   w_99 = w_3;
fi;
x_1 = x_2 = good_99 .5r;
cpen;   top_99 y_1 = h;   y_2 = .5[c, m];
call `a cdraw(1, 2, 99, 0).                                    % stem
```

ITALIC CHARACTER DESIGNS

The file italic.mf

```
% The Computer Modern Italic family of fonts (by D. E. Knuth, 1979).
danger = mi/8;
input romitu;                                          % upper case (majuscules)
input itall;                                           % lower case (minuscules)
input itald;                       % numerals, ampersand, and question mark
input romitp;                  % punctuation symbols common to all roman and italic
if mi ≠ 0:                       % the following is the "easy" case, a math italic font
    input greekl;                                      % lower case Greek letters
    input italms;                              % special symbols for math italic
    input itmoxt;                 % nonstandard characters (codes '134, '136, '137)
    texinfo slant, 6pu, 3pu, 2pu, px, 18pu, 2pu;
else:                            % the following is the "hard" case, a text italic font
    input romita;      % accents and other symbols common to roman and italic text
    if ligs ≠ 0:  input italig;               % letter ligatures (codes '173-'177)
        input itals;                         % miscellaneous letter combinations
        input romitl;                             % ligatures common with italic
        input ittext;               % nonstandard characters (codes '043, '044)
    else:  input romits;                             % substitutes for ligatures
    fi;
    if fixwidth = 0:  new k, kk, kkk;                   % three degrees of kerning
        k = --.5pu;   kk = −1.5pu;   kkk = −2.5pu;   uk = +pu;
        lig `d:  `w:  `1:  `l kern uk;
        lig `F:  `V:
            `A kern kkk, `o kern kk, `e kern kk,
            `a kern kk, `u kern kk, `r kern kk,
        `K:  `X:
            `O kern k, `C kern k, `G kern k, `Q kern k;
        l,g `T:  `y kern kk,
        `Y:  `o kern kk, `e kern kk,
            `a kern kk, `u kern kk, `r kern kk,
        `P:  `W:  `A kern kk;
        lig `O:  `A kern k, `W kern k, `Y kern k, `V kern k, `X kern k;
        if ucs ≠ 0:  lig `R:  ;
        fi;
        lig `A.  `t kern k, `b kern k, `h kern k, `k kern k, `l kern k,
            `m kern k, `n kern k, `r kern k, `v kern k, `w kern k,
            `L.  `ı kern k, `u kern k,
            `T kern kk, `O kern k, `U kern k, `C kern k,
            `W kern kk, `Y kern kk, `G kern k, `V kern kkk,
            `Q kern k,
            `b:  `c:  `e:  `o:  `p:  `r:
            `a kern k, `c kern k, `d kern k, `e kern k, `g kern k,
            `o kern k, `q kern k;
```

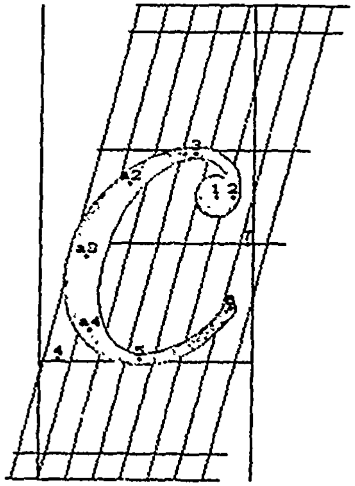


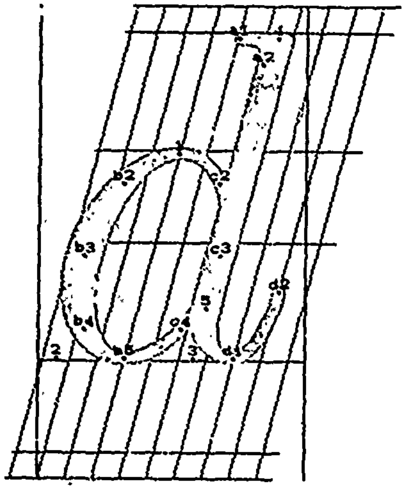


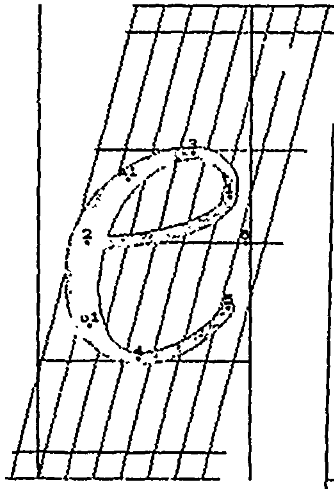
```
        texinfo slant, 6pu, 3pu, 2pu, px, 18pu, 2pu;
    else:   texinfo slant, 9pu, 0, 0, px, 9pu, 9pu;
        fi;
fi.
```

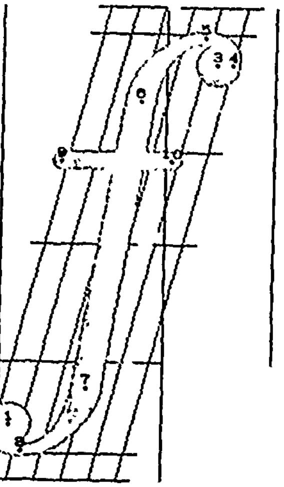
The file itall.mf

```
% This lower-case italic alphabet was prepared by D E Knuth in December, 1979,
% inspired by the Monotype alphabet used in The Art of Computer Programming.
% Math spacing is obtained by setting mi = 1, otherwise set mi = 0.
% Character codes '141 -'172 are generated.
new mc, lbowl, lhook, rbowl, rhook, rstem;          % quantities used in spacing corrections
mc = mi/pu;
rhook = ½px·slant + .5pw + 5pu;
lbowl = 3px·slant − .5pwii + pu;
rbowl = 7px·slant + .5pwii − pu;
lhook = ¾px·slant − .5pw − .5pu;
rstem = px slant + 5pwi − pu;
"Italic letter a";
call charbegin('a, 9, mc·lbowl, −mc·rhook, px, 0, mi[rhook, 0]);
cpen;   x1 = .5[x2, x3];   x2 = good2 1.5u;   x3 = x4 = x5 = good1(r − 2.5u);
top0y1 = m + oo;   bot0y2 = −oo;   y3 = y2;   top1y4 = m − 02h;
call 'a darc(1, 2, w2);   call 'b darc(1, 3, w0);                   % bowl
w1 draw 4;                                          % make end point round
call 'c exit(5, r);                                        % closing hook
hpen;   w1 draw 4..5.                                               % stem

"Italic letter b";
call charbegin('b, 8, mc·lbowl, −mc·rbowl, ph, 0, mi[rbowl, 0]);
hpen;   x1 = x2 = good1 1.5u;   x5 = good2(r − 1 5u);   x3 = x4 = 5[x2, x5];
top1y1 = h;   y2 = .5[y3, y4];   top0y3 = m + oo,   bot0y4 = −oo;   y5 = y4;
call 'a serif(1, 1, 2, −lcs);                                       % serif
w1 draw 1..2;                                                       % stem
call 'b arc(3, 2, w0);   call 'c arc(4, 2, w1);          % left part of bowl
call 'd darc(3, 5, w2).                                 % right part of bowl
```

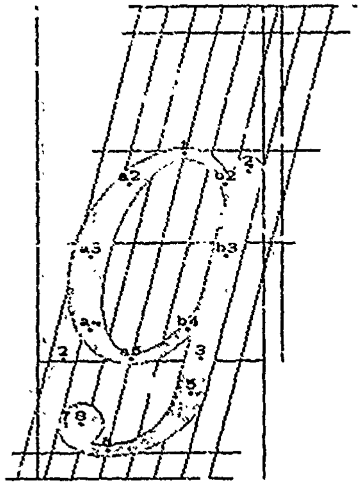


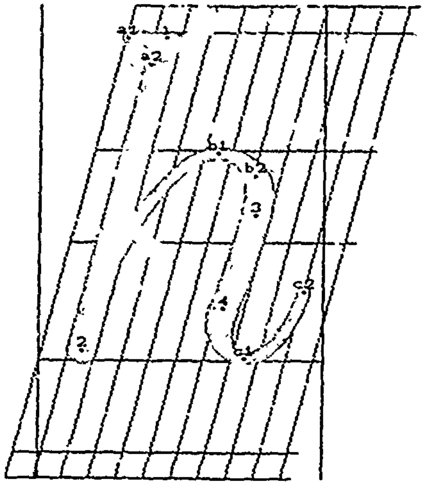


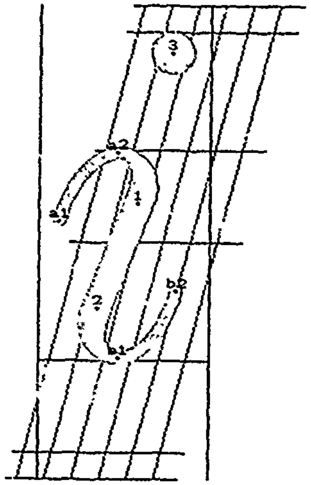


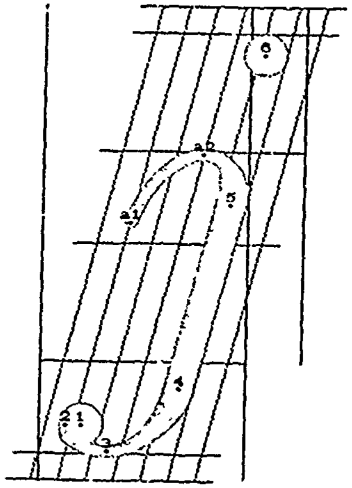


```
"Italic letter c";
call charbegin(`c, 8, mc·lbowl, −⅓mc·px·slant, px, 0, mi[px·slant − pu, 0]);
hpen;   rt3x1 = rt0x2 = round(r − 1.5u);   x3 = x5 = .5(. + u);   x1 = good2 1.5u;
rt0x6 = r − .5u;   top0y6 = .5e;   x7 = x6;   y7 = e;
y1 = y2 = .5[e, m];   top0y3 = m + oo;   bot0y4 = −oo;   y5 = y4;
w0 draw 2{0, 1}..3{−1, 0};                                              % shoulder
call `a darc(3, 4, w2);                                                     % bowl
w0 draw 5{1, 0}..6(..7);                                                   % point
cpen;   w1 draw 1.                                                          % bulb

"Italic letter d";
call max(ph·slant + .5pwi − 2pt, rhook);
call charbegin(`d, 9, mc lbowl, − nc·acc, ph, 0, mi[acc, 0]);
hpen;   x1 = .5[x2, x3];   x2 = good2 1.5u;   x3 = x4 = x5 = good1(r − 2.5u);
top1y4 = h;   top0y1 = m + oo;   bot0y2 = −oo,   y3 = y2;
call `b darc(1, 2, w2);   call `c darc(1, 3, w0);                       % bowl
call `d exit(5, r);                                                % closing hook
call `a serif(4, 1, 5, −lcs);                                              % serif
w1 draw 4..5.                                                               % stem

"Italic letter e";
call charbegin(`e, 8, mc·lbowl, −⅓mc·px·slant, px, 0, mi[px·slant − pu, 0]);
hpen;   rt0x1 = round(r − 1.5u);   x2 = good2 1.5u;
x3 = x4 = 5(r + u);   rt0x5 = r − .5u;   x6 = x5;
y1 = .5[e, m];   y2 = e;   top0y3 = m + oo;   bot0y4 = −oo,   top0y5 = .5e,   y6 = e;
w0 draw 2{1, 0}..1{0, 1}..3{−1, 0}..3{−1, 0};                  % bar and shoulder
call `a arc(3, 2, w2);   call `b arc(4, 2, w2);                            % bowl
draw 4{1, 0}..5(..6).                                                      % point

"Italic letter f";
call charbegin(`f, 7, l − fixwidth − mc(pd slant + pu),
                  l − fixwidth − mc(px·slant), ph, pd, ph slant + 75pu − mi·px·slant);
cpen;   lft1x1 = lft0x2 = round.75u,   rt1x3 = rt0x4 = round(r − 75u);
x5 = r − 2 25u;   x6 = good1(.5r − .5u);   x7 = good1(5r + .5u);   x8 = 2.25u;
bot1y1 = −.9d;   y2 = y1;   y3 = y4;   y5 − y4 = y2 − y8;
top0y3 = h + oo;   y5 − y6 = y7 − y8;   bot0y7 = −½d;   bot0y8 = −d − oo;
x9 = x6 − 2 25u − eps;   x10 = x6 + 1.75u + eps;   top10y9 = m;   y9 = y10.
w1 draw 1,   draw 3;                                                       % bulbs
w10 draw 9..10;                                                              % bar
hpen;   draw |w0|4{0, 1}   |w0#|5{−1, 0}   |w1#|6{x7 − x6, y7 − y6}
     |w1#|7{x7 − x6, y7 − y6}   |w0#|8{−1, 0}. 2{0, 1}.                   % stem
```

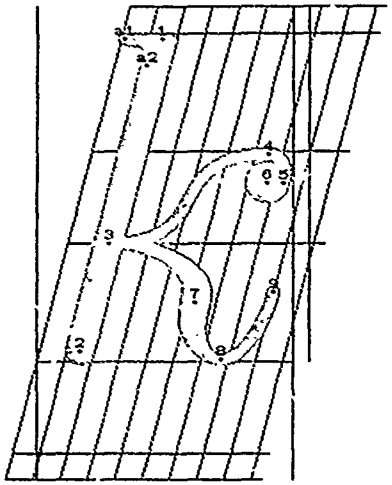


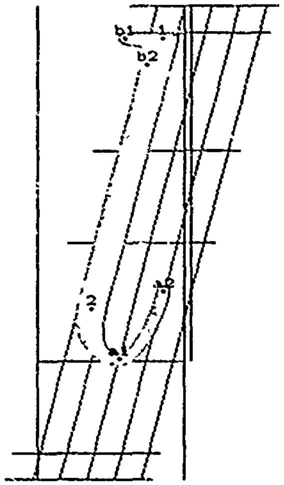


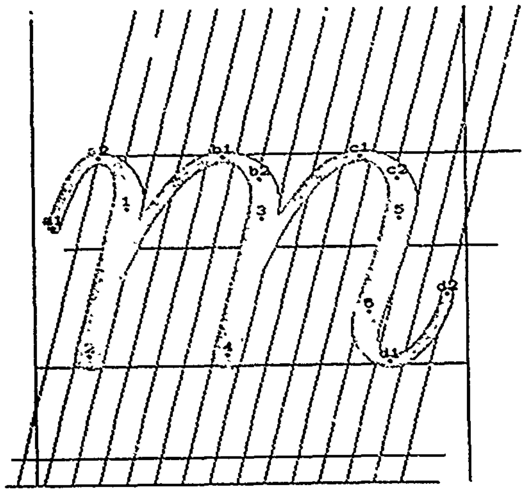


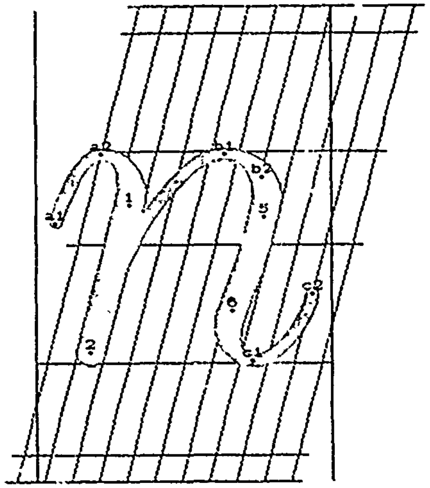


```
"Italic letter g";
call max(—lbowl, pd·slant — 1 5pu),
call charbegin(˜g, 8, —mc·acc, —mc(r stem — ⅓px slant), px, pd,
                    mi[rstem, ⅓px·slan ]);
cpen;   x1 = x6 = .5r;   x2 = good   5u;   x3 = x4 = x5 = good1(r — 1.5u);
lft3x8 = lft0x7 = round 2u;
top6y1 = m + oo;   bot6y2 = —oo,   y3 = y2;   top1y4 = m — 02h;   y5 = —½d,
bot6y6 = —d — oo;   bot3y7 = —.9d,   y8 = y7;
w1 draw 8;                                                          % bulb
w1 draw 4;                                             % make end point round
call ˜a darc(1, 2, w2);                                   % left part of bowl
call ˜b darc(1, 3, w0);                                  % right part of bowl
hpen;   draw |w0|4 . . |w1#|5{0, — 1}   |w0#|6{—1, 0}   7{0, 1}.    % stem and tail

"Italic letter h";
call charbegin(˜h. 9, 0, —mc rhook, ph, 0, mi[rhook, 0]);
cpen;   x1 = x2 = good1 1.5u;   x3 = good1(r — 2 5u)   x4 = x3 — 25u,
top0y1 = h,   bot1y2 = —oo;
w1 draw 2;                                             % make end point round
call ˜a serif(1, 1, 2, —lcs);                                       % serif
hpen;   w1 draw 1 . . 2;                                             % stem
call ˜b italhstroke(2, 3);                                         % stroke
call ˜c skewexit(4, r);                                      % closing hook
draw 3{0, —1} . . 4{—u, —m}.                                         % link

"Italic letter i";
call max(rhook, ph·slant + 5pwii — 2pu);
call charbegin(˜ı, 7, 1 — fixwidth + mc lhook, 1 — fixwidth — mc acc, ph, 0, mi[acc, 0]),
x1 = 5r + .25u;   x2 = 5r — .25u;
call ˜a skewentry(u, 1);                                     % opening hook
call ˜b skewexit(2, r — u);                                  % closing hook
hpen;   w1 draw 1 . 2;                                               % stem
cpen;   top3y3 = h;   x3 = 5r;   w1 draw 3                            % dot

"Italic letter j";
call charbegin(˜j, 7.5, 1 — fixwidth — mc(pu + pd·slant),
                    1 — fixwidth — mc(pe slant + 5pwi — 1 5pu), ph, pd,
                    mi[ph slant + 5pwi — 1 5pu, (ph   pe) slant]),
cpen;   lft3x1 = lft0x2 = round .5u,   x4 = ? 5u,   x3   x5 = good1 4.5u,   rt1x6 — rt1x1,
top1y6 = h;   bot1y3 = —.9d;   y2 = y1   bot0y4 = —d — oo,   bot0y5 = —½d,
w3 draw 1;                                                          % bulb
draw 6;                                                              % dot
call ˜a entry(u, 5);                                         % opening hook
hpen;   draw |w1|5 . |w1#|4{0, —1}   |w0#|3{—1, 0}   2{0, 1}     % stem and tail
```

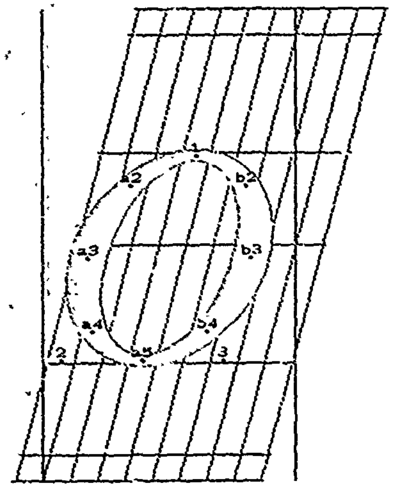


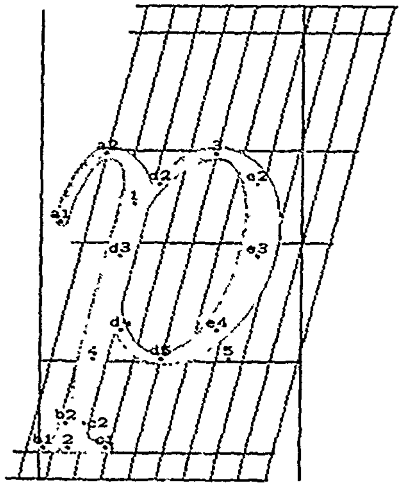


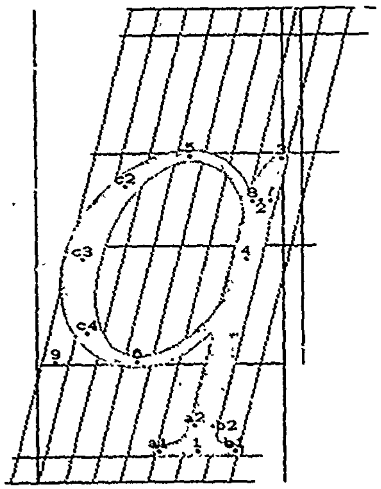




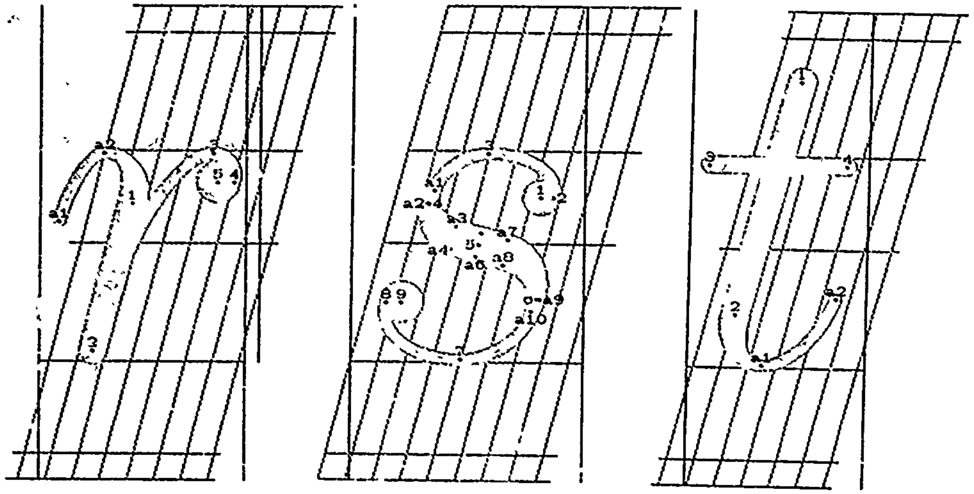
```
'Italic letter k";
call charbegin(`k, 8, 0, —mc·rhook, ph, 0, mi[px·slant, px slant — rhook]);
cpen;   x1 = x2 = x3 = good1 1 5u;   x1 = r — 1.5u;
rt3x6 = rt0x5 = round(r — 5u);   x7 = good1(r — 2.75u);
x8 = r — 1.25u;   x9 = good0r;
top6y1 = h;   bot1y2 = —oo;   y1 = good0e;   top6y1 = m + oo,   y5 = y6 = 2/3[e, m];
y7 = .5e;   bot6y8 = —oo;   y9 = 1/3m;
w1 draw 2;                                                % make end point round
w3 draw 6;                                                                % bulb
call `a serif(1, 1, 2, —lcs);                                             % serif
hpen;   w1 draw 1..2;                                                      % stem
w0 draw 3{1, 0} .4{1, 0}   5{0, --1},                          % upper diagonal
draw |w0#|3{1, 0}.  |w1#|7{0, —1}..
     |w0#|8{1, 0}  .9{0, 1}.                  % lower diagonal and closing hook

"Italic letter l";
call max(rhook, ph·slant + .5nwi — 2pu);
call charbegin(`l, 6, 1 — fixwidth, 1 — fixwidth -- mc rhook, ph, 0, acc — mi·rhook),
hpen;   x1 = x2 = good1 2.5u,   top1y1 = h;
call `a exit(2, r — u);                                            % closing hook
call `b serif(1, 1, 2, —lcs);                                             % serif
w1 draw 1..2                                                               % stem

"Italic letter m";
call charbegin(`m, 15, mc·lhook, —mc·rhook, px, 0, mi[rhook, 0]),
cpen;   x1 = x2 = good1 2.5u;   x3 = x4 = good1 5r,   x5 — x3 =  x3 — x1,   x6 — x,    25u,
bot1y2 = —oo;   y1 = y2,   w1 draw 2;   draw 4;            % make end points round
call `a entry(0, 1),                                               % opening hook
hpen;   w1 draw 1..2,                                                 % left stem
call `b itallhstroke(2, 3);                                         % left stroke
draw 3..4;                                                          % middle stem
call `c itallhstroke(4, 5),                                        % right stroke
call `d skewexit(6, r);                                            % closing hook
draw 5{0, —1} .6{—u, —m}.                                            % right stem

"Italic letter n";
call charbegin(`n, 10, mc lhook, --mc rhook, px, 0, mi[rhook, 0]),
cpen,   x1 = x2 = good1 2 5u    x5    good1(r — 2 5u),        — x5 — 25u,
bot1y2 = —oo,   w1 draw 2,                                % make end point round
call `a entry(0, 1);                                               % opening hook
hpen,   w1 draw 1 .2;                                                 % left stem
call `b itallhstroke(2, 5);                                              % stroke
call  c skewexit(6, r),                                            % closing hook
draw 5{0, —1}..6{—u, —m}.                                            % right stem
```



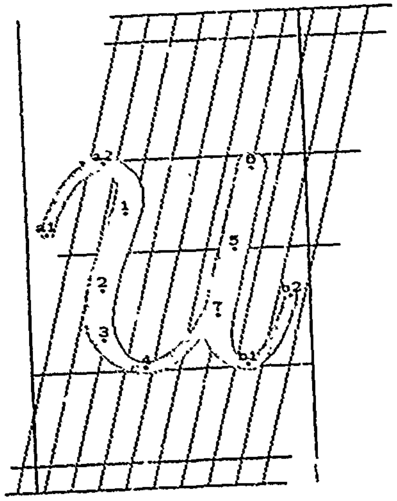


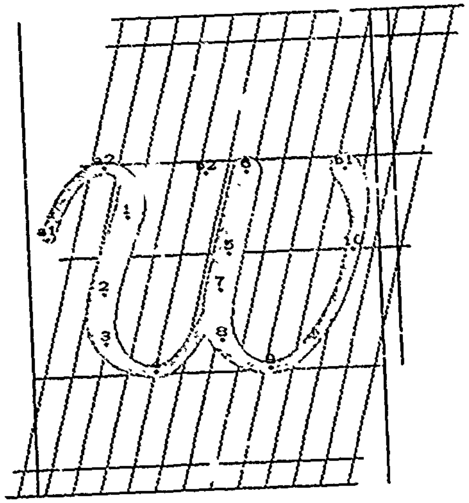


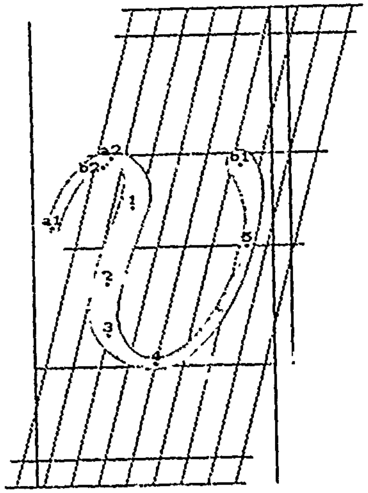
```
"Italic letter o";
call charbegin(`o, 9, mc·lbowl, −mc·rbowl, px, 0, mi[rbowl, 0]);
hpen;   x1 = r − x1;                                    % axis of left-right symmetry
x2 = good2 1.5u;
x1 − x2 = x3 − x1;   top0y1 = m + oo;   bot0y2 = −oo;   y2 = y3;
call `a darc(1, 2, w2);                                        % left part of bowi
call `b darc(1, 3, w2).                                        % right part of bowl

"Italic letter p";
call max(−lhook, pd·slant + 5pwi − 2pu);
call charbegin(`p, 9, −mc·acc, −mc·rbowl, px, pd, mi[rbowl, 0]),
x1 = x2 = x3 = good1 2.5u;   x4 = .5[x1, x5],   x5 = good2(r − 1.5u);
hpen;   bot1y2 = −d;   top0y3 = m + oo;   bot0y4 = −oo;   y5 = y3;
call `a entry(0, 1),                                              % opening hook
w1 draw 1 . 2;                                                           % stem
call `b serif(2, 1, 1, −.5lcs);   call `c serif(2, 1, 1, lcs);           % serif
call `d darc(3, 4, w3);                                        % left part of bowl
call `e darc(3, 5, w2).                                        % right part of bowl

"The letter q";
call charbegin(`q, 10, mc·lbowl, 1 − fixwidth − mc(rstem − ½px·slant),
                        px, pd, mi[rstem, ½px slant]),
hpen;   x1 = good1(r − 2.5u);   x5 = .5(r − u),   x2 = x1 = x1,   bot1y1 = −d,
rt0x7 = rt1x1;   x3 = x7;   x5 = x6;   lft0x8 = lft1x2;
top0y3 = m;   y4 = .5[y5, y6];   top0y5 = m + oo,   bot0y6 = −oo;
new aa;   lft1x2 = aa[x6, x1],
y2 = y7 = y8 = (sqrt(1 − aa aa))[y1, y5];                % where bowl meets stem
if lcs ≠ 0:   call `a serif(1, 1, 2, −lcs);
     call `b serif(1, 1, 2, lcs),                                  % lower serif
fi;
w1 draw 1 .. 2;                                                          % stem
w3 ddraw 7 .. 3, 8{0, 1}   3{x3 − x8, .5(y3 − y8)};                      % spur
w3 draw 6{1, 0} . 4{0, 1} . 5{−1, 0};                          % right part of bowl
if w2 > 1.5u:   lft2x9 = round .75u;
else.   x9 = good2 1.5u;
fi;
y9 = y6;   call `c darc(5, 9, w2).                              % left part of bowl
```



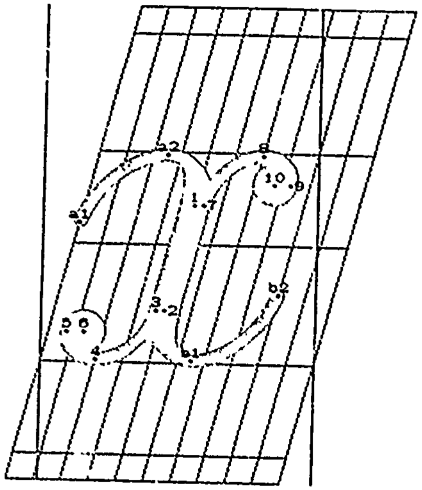
```
"Italic letter r";
call charbegin(`r, 7, mc·lhook, —mc(px·slant — 75pu),
                    px, 0, mi[px slant — .25pu, 5pu]);
cpen;   x1 = x2 = good1 2.5u;   x3 = r — 2u;   rt3x5 = rt0x4 = round(r — 75u);
bot1y2 = —oo;   top6y3 = m + oo;   y4 = y5 = ⅔[e, m];
w1 draw 2;                                                    % make end point round
w3 draw 5;                                                                  % bulb
call `a entry(0, 1);                                               % opening hook
hpen;   w1 draw 1 . . 2;                                                    % stem
w0 draw 2{0, 1} . . 3{1, 0} . . 4{0, —1}.                                 % stroke

"Italic letter s";
call charbegin(`s, 7, 0, —mc(px·slant — .5pu), px, 0, mi[px slant — 5pu, 0]);
cpen,   rt2x1 = rt0x2 = round(r — u),   x3 = 3u;   lft11x4 = round u;
x5 = 5r;   rt11x6 = round(r — 5u),   x7 = r — 3u,   lft0x8 = lft3x9 = round .5u;
y1 = y2 = 5[e, m];   top6y3 = m + oo,   bot6y7 = —oo;   y8 = y9 = 5e,
(y5 — w6 — .5w8)/(m + o — 2w6 — w8) = e/m;                  % white space ratio
w2 draw 1;   w3 draw 9;                                                    % bulbs
hpen   w0 draw 2{0, 1} . 3{—1, 0},   draw 8{0, —1} . 7{1, 0},              % links
new aa;
if m — e > e.   aa = m — e;
else.   aa = e,
fi;
call `a sdraw(3, 4, 5, 6, 7, w11, w8, —aa/(18u)).                         % stroke

"Italic letter t";
cpen;   call max(rhook, px·slant — 5pu + 5pw);
if px — pe < .75(ph — px)·   top1y1 = 2m — e;
     call charbegin(`t, 7 5, 1 — fixwidth + mc(px slant — pu — .5pw),
                          1 — fixwidth — mc·acc, 2px — pe, 0, mi[acc, 0]);
else:   top1y1 = 75[m, h];
     call charbegin(`t, 7 5, 1 — fixwidth + mc(px·slant — pu — 5pw),
                          1 — fixwidth — mc acc, 75[px, ph], 0, mi[acc, 0]);
fi;
x1 = x2 = good1 3u;   x3 = x1 — 2 5u — eps;   x4 = x1 + 2 5u + eps;
w1 draw 1;                                                    % make end point round
top10y3 = m;   y4 = y3;   w10 draw 3   4,                                  % bar
call `a exit(2, r — u);                                            % closing hook
hpen,   w1 draw 1 . 2.                                                      % stem
```

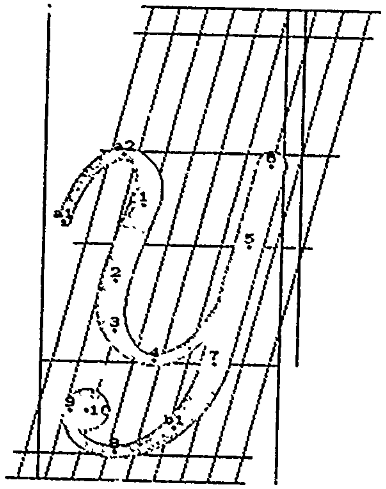


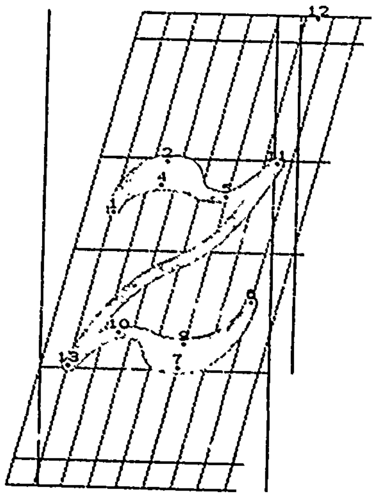




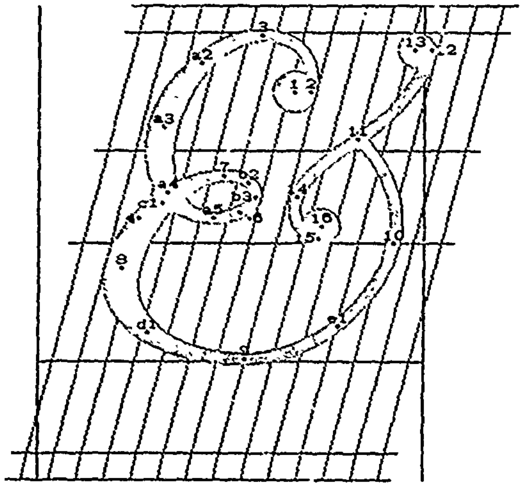
```
:talic letter u",
call charbegin(~u, 9.5, mc lhook, —mc rhook, px, 0, m[rhook, 0]),
cpen;   x1 — .25u = x2 = good1 2 5u;   x3 = x2 + 5u,   x4 =  5[x2, x5];
x5 = x6 = x7 = good1(r — 2.5u),
y2 = .7c;   y3 = .25[y1, c];   bot0y1 = —oo;   y5 = c,   top1y6 = m + oo,
                                                            % make end point round
w1 draw 6;                                                          % opening hook
call ~a skewentry(0, 1);
hpen;   draw |w1|1{—u, —m}   |w1#|2{0, —1}. |.75[w0, w1]|3 . .        % stroke
      |w0#|4{1, 0} . . 5{0, 1},                                    % closing hook
call ~b exit(7, r);                                                      % stem
w1 draw 6 . . 7.

"Italic letter v";
call charbegin(~v, 8, mc·lhook, —⅓mc·px slant, px, 0, m[px·slant, ⅓px slant]),
x2 = good1 2 5u;   x1 = x2 + .25u,   x3 = x2 + .5u;                 % opening hook
call ~a skewentry(0, 1);
hpen;   y2 = .7[y1, c];   y3 = 25[y1, c],   bot0y1 = —oo,   x4 = 5u,
rt0x5 = round(r — 5u);   y5 = c;
draw |w1|1{—u, —m}   |w1#|2{0, —1}   |.75[w0, w1]|3                    % stroke
      |w0#|4{1, 0} . 5{0, 1};                                      % closing bulb
call ~b endv(5)

"Italic letter w";
call charbegin(~w, 12, mc lhook, —⅓mc·px·slant, px, 0, m[px slant, ⅓px slant]),
cpen;   x1 — .25u = x2 = good1 2 5u,   x3 = x2 + 5u,   x4 = 6[x2, x5],
x5 = x6 = x7 = good1 6 75u;   x8 = x7 + 5u,   x9 = r — 2 75u,   rt0x10 = round(r — 5u),
y2 = .7c;   y3 =  25[y1, c];   bot0y1 = —oo,   y5 = c,   top1y6 = m + oo,
                                                            % make end point round
w1 draw 6;
y7 = y2;   y8 = y3,   y9 = y4,   y10 = y5;                          % opening hook
call ~a skewentry(0, 1),
hpen;   draw |w1|1{—u, —m}   |w1#|2{0, —1}   |.75[w0, w1]|3            % left stroke
      |w0#|4{1, 0}   5{0, 1},                                      % right stroke
draw |w1|6 . . |w1#|7{0, —1}   |.75[w0, w1]|8   |w0#|9{1, 0}   10{0, 1},  % closing hook
call ~b endv(10).
```

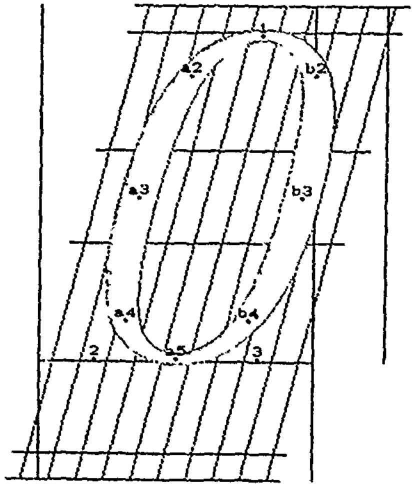






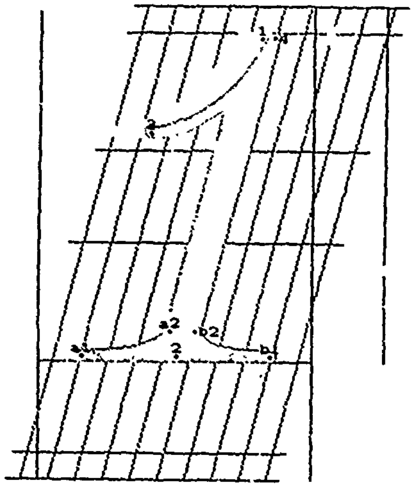
```
"Italic letter x";
if px slant > rhook·   call charbegin(`x, 8, 0, − mc·px·slant, px, 0, mi[px·slant, 0]);
else:   call charbegin(`x, 8, mc lhook, −mc·rhook, px, 0, mi[rhook, 0]),
fi;
cpen;   x1 = x2 = good1 5r,   lft1x2 = lft0x3;   x4 = 2u,   lft0x5 = lft1x6 = round 5u,
rt1x1 = rt0x7;   x8 = r − 2u;   rt0x9 = rt1x10 = round(r − 5u);
y1 = y2;   bot0y1 = −oo,   y5 = y6,   y7 = y1,   top0y8 = m + oo;   y9 = y10,
y8 − y9 = y5 − y4;   y9 = ⅔[e, m];
call `a entry(0, 1);                                                   opening hook
call `b exit(2, r);                                                  % closing hook
w3 draw 6;   draw 10;                                                       % bulbs
hpen;   w0 draw 3{0, −1}   4{−1, 0}..5{0, 1};                        % lower left link
draw 7{0, 1}  .8{1, 0}..9{0, −1};                                   % upper right link
w1 draw 1..2.                                                                % stem

"Italic letter y",
call charbegin(`y, 8.5, mc lhook, −mc(rstem − ½px slant),
                     px, pd, mi[rstem, ½px·slant]),
cpen;   x1 − .25u = x2 = good1 2.5u,   x3 = x2 + .5u;   x4 = 5[x2, x5],
x5 = x6 = x7 = good1(r − 1.5u);   x8 = 5r,   lft0x9 = lft1x10 = round 2u,
y2 = .7e;   y3 = 25[y1, e];   bot0y1 = −oo,   y5 = e;   top1y6 = m + oo,
w1 draw 6;                                                % make end point round
y7 = 0;   bot0y8 = −d − oo;   y9 = y10,   bot1y10 = − 75d,   w1 draw 10,      % bulb
call `a skewentry(0, 1);                                           % opening hook
hpen;   draw |w1|1{−u, −m}  .|w1#|2{0, −1}   |75[w0, w1]|3  .
     |w0#|4{1, 0}..5{0, 1};                                             % stroke
w1 draw 6..7;                                                             % stem
call `b arc(8, 7, w1);                                                     % tail
w0 draw 8{−1, 0}   9{0, 1}.                                                % link

"Italic letter z";
call charbegin(`z, 7, 0, −mc rhook, px, 0, px slant + 5pw − mi rhook),
vpen;   x1 = good0u,   x2 − x1 = 2.5u,   x5 = 5u;
x6 = good0r;   x7 = x9 = 5u;   x10 = 2.5u;
x11 = x12 = good0(r − .5u);   x13 = x14 = x1,
y1 = 75m;   top0y2 = top8y1 = m + oo;   bot8y4 = bot6y1,   y5 = 825m,
y6 = ¼m,   bot0y7 = bot8y8 = −oo,   top8y8 = top6y9,   y10 = 175m,
y11 = y2,   y12 = y11 + (h + b − m);   y13 = y7,   y14 = y13   (h + b   m),
w6 ddraw 1{0, 1}   2{1, 0}   5{1, 0}, 1{0, 1}   4{1, 0}   5{1, 0},          % upper bar
ddraw 10{1, 0}   9{1, 0}   6{0, 1}  10{1, 0}   7{1, 0}   6{0, 1},            % lower bar
draw 5{1, 0}  .11(   12),   draw (11   )13   10{1, 0},                       % links
draw 11{x13 − x11, 2(y13 − y11)}   13{x11 − x13, 2(y11 − y13)}             % diagonal
```

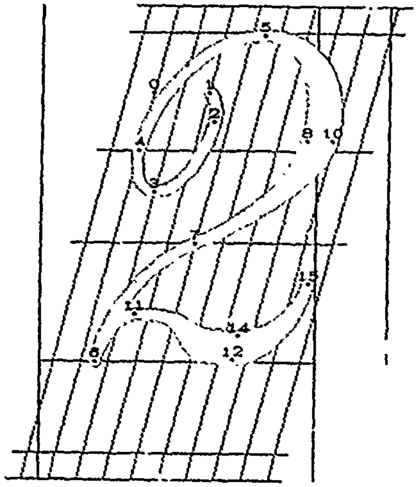


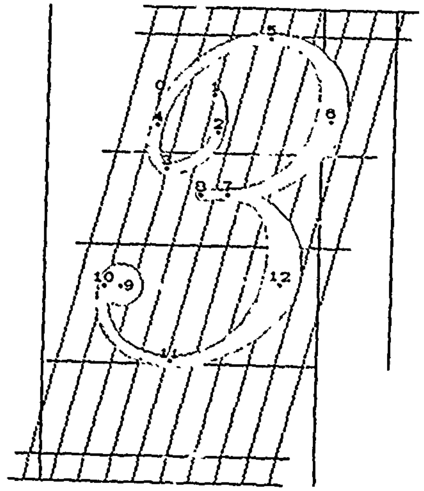


The file itald mf

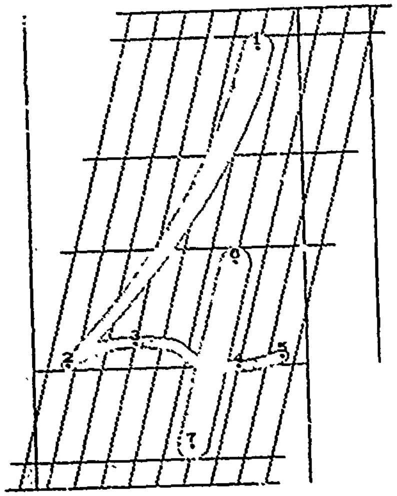
```
% This file contains the ten digits, as well as '&' and '?',
% in the so-called italic style.
% Codes '046, '060-'071, and '077 are used

"Italic ampersand";
call charbegin('046, 13, 0, 0, ph, 0, 0);
hpen;   rt_3x_1 = rt_0x_2 = round .5(r + u);   y_1 = y_2 = 5[-n, h];
x_3 = 4.5u;   top_0y_3 = h + oo;   ;
lft_1x_4 = round 1.25u,   top_0y_4 = round 1/3[e, n];   x_7 = x_3;
rt_0x_6 = round 6u;   y_6 = y_4;   bot_0y_7 = round 2/3[e, m];
lft_2x_8 = round u;   x_9 = 7u;   y_8 = .5[y_7, y_9]·   bot_0y_9 = -oo;
rt_0x_10 = round(r - 1.5u);   y_10 = e;
w_0 draw 2{0, 1} . . 3{-1, 0};                                  % shoulder
call 'a darc(3 4, w_1);                                        % upper bowl
call 'b darc(7, 6, w_0);                                              % loop
call 'c arc(7, 8, w_2);   call 'd arc(9, 8, w_2);            % lower bowl
call 'e arc(9, 10, w_0);                                              % link
x_11 = 9u;   y_11 = .5[e, h];
rt_3x_13 = rt_0x_12 = round(r - 2u),   y_12 = y_13,
rt_0x_14 = round(r - 5.5u):   y_14 = .5[e, m],
x_15 = x_16 = r - 4 5u;
cpen;   top_2y_13 = h;   bot_2y_16 = bot_6y_15 = round e;
w_3 draw 1;   w_2 draw 13;   draw 16,                                % bulbs
hpen;   w_0 draw 10{0, 1} . . 11{2(x_11 - x_10), y_11 - - y_10};       % stem
draw 12{0, -1} . 11{2(x_11 - x_12), y_11 - y_12} . 14{0, -1}   15{1 0}.   % arms

"Italic numeral 0";
% (Same as in the roman font, except for spacing.)
call charbegin('0, 9, 0, 0, ph, pd, ph·slant - 5pu),
if fixwidth = 0:   new save;   save = sqrttwo;   new sqrttwo;
    sqrttwo = sqrt(1 23114413save);                  % the constant is 2^(1/10)
fi;
hpen;   x_2 = good_2 1.5u;
x_1 = r - x_1;                                 % axis of left-right symmetry
x_3 = r - x_2;   top_0y_1 = h + oo,   bot_0y_2 = -oo;   y_3 = y_2,
call 'a darc(1, 2, w_2),   call 'b darc(1, 3, w_2);                   % bowl
if fixwidth = 0:   new sqrttwo;   sqrttwo = save;
fi;
```

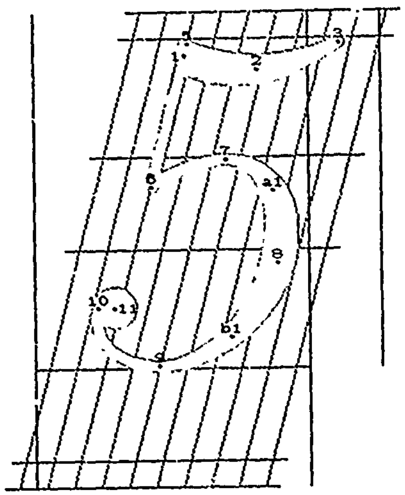


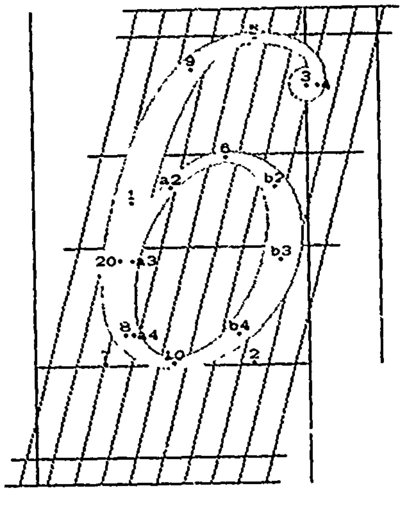




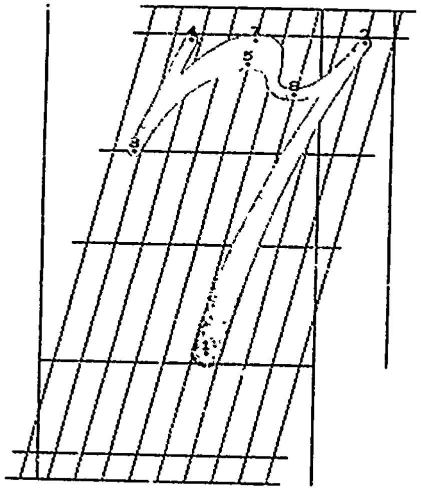
```
"Italic numeral 1";
call charbegin(`1, 9, 0, 0, ph, pd, ph slant − .5pu);
hpen;  x1 = x2 = good2 .5r;  top2 y1 = h,  bot2 y2 = 0;
w2 draw 1..2;                                                      % stem
call `a serif(2, 2, 1, −3);
call `b serif(2, 2, 1, 3);                                         % serif
top0 y3 = .2[m, h];  x3 = lft2 x1 − 2.5u − eps;
y4 = y3;  rt2 x1 = rt0 x4;  y5 = 1.5[m, h];  x4 = x5;
lpen#;  w2 draw (5..)4..3{−1, 0};                                  % erase excess
hpen;  w0 draw (5..)4..3{−1, 0}.                                   % point

"Italic numeral 2";
call charbegin(`2, 9, 0, 0, ph, pd, ph·slant − .5pu);
hpen;  x0 = u;  y0 = .5[m, h],  x1 = 3u;  y1 = y0,  x2 = good0 3.5u;  y2 = .25[m, h];
x3 = 2u;  bot0 y3 = round .5[e, m],
x4 = good0 u;  y4 = m;  x5 = .5r,  top0 y5 = h + oo,
x9 = good2(r − 1.5u);  lft2 x9 = lft0 x8,  rt2 x9 = rt0 x10,  y8 = y10 = .5[y7, y5];
x7 = 4u;  y7 = e;  x6 = good0 1.5u;  bot0 y6 = −o,
x11 = 2.5u;  y11 = .4e;
vpen;  bot8 y14 = −oo = bot0 y12,  top7 y14 = top0 y13;  x12 = x14 = 6.5u;
x15 = good0(r − .5u);  y15 = ⅔c,
hpen;  w0 draw (0..)1..2{0, −1}..3{−1, 0}..4{0, 1}..5{1, 0};     % shoulder
ddraw 5{1, 0}..8{0, −1}..7{2(x7 − x10), y7 − y10},
    5{1, 0}..10{0, −1}..7{2(x7 − x10), y7 − y10};                 % bowl
draw 7{2(x7 − x10), y7 − y10}..6{0, −1},                          % link
draw 6{0, 1}..11{1, 0};                                            % left part of bar
ddraw 11{1, 0}..14{1, 0}..15{0, 1}, 11{1, 0}..12{1, 0}..15{0, 1}   % bar

"Italic numeral 3";
call charbegin(`3, 9, 0, 0, ph, pd, ph slant − .5pu);
hpen;  x0 = u;  y0 = .5[m, h],  x1 = 3u,  y1 = y0;  x2 = good0 3.5u,  y2 = .5[y1, y4],
y7 = y4 = .52h;  x3 = 2u;  bot0 y3 = round .125[y7, h];
lft0 x4 = round u,  y4 = ½[y3, y5],
x5 = .5r;  top0 y5 = h + oo;  rt1 x6 = round(r − u),  y6 = .75h;  x7 = .5r,  x8 = x7 − u;
lft3 x9 = lft0 x10 = round .75u;  y9 = y10;
cpen;  top3 y9 = .3h,  w3 draw 9;                                  % bulb
hpen;  bot0 y11 = −oo,  x11 = .5[x10, x12];  rt1 x12 = round(r − u),  y12 = .25h;
w0 draw (0..)1..2{0, −1}..3{−1, 0}..4{0, 1}..5{1, 0},              % shoulder
draw |w0#|5{1, 0}..|w1#|6{0, −1}..|w0#|7{−1, 0}·                   % upper bowl
draw 7..8;                                                         % bar
draw |w0#|7{1, 0}..|w2#|12{0, −1}..|w0#|11{−1, 0},                 % lower bowl
draw 11{−1, 0}..10{0, 1}.                                          % link
```

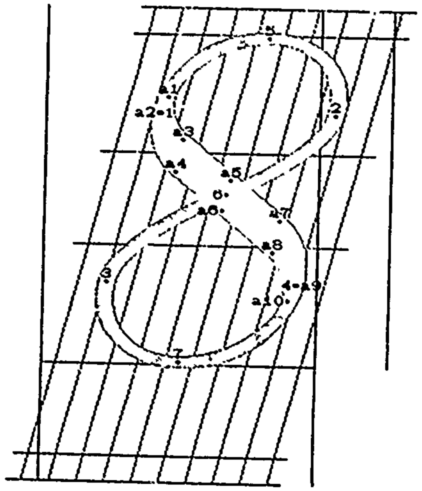




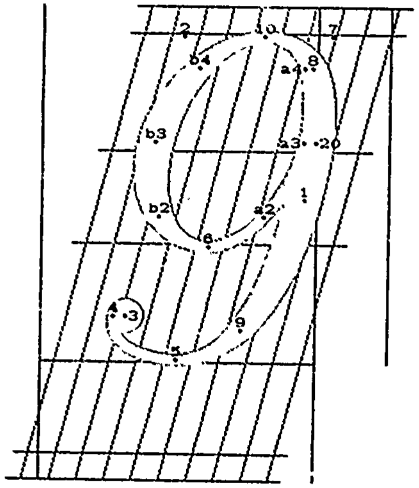


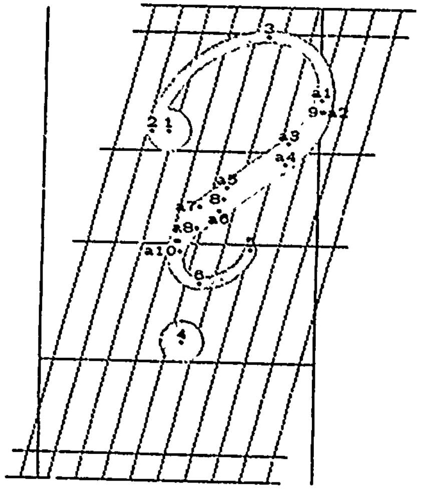
```
"Italic numeral 4";
call charbegin(`4, 9, 0, 0, ph, pd, ph·slant — 5pu);
cpen;   top1y1 = h + oo;   x1 = good1 5u;   lft0x2 = round .5u;   bot6y2 = 0;
x3 = 3u;   y3 = .08h;   x4 = r — 2u;   y4 = 0;   rt0x5 = round(r — .25u),   y5 = .03h,
x6 = x7 = 2/3r;   top1y6 = e;   bot1y7 = —d,                    % make end point round
w1 draw 1;                                                                   % stem
draw 6..7;                                                               % diagonal
hpen;   draw |w1#|1{0, —1}..|w0#|2{2(x2 — x1), y2 — y1};                      % bar
w0 draw 2{2(x1 — x2), y1 — y2}..3{1, 0}..4{1, 0}..5{x5 — x4, 2(y5 — y4)}

"Italic numeral 5";
% (Same as in the roman font, except for spacing.)
call charbegin(`5, 9, 0, 0, ph, pd, ph·slant — 5pu);
vpen;   x1 = good8 2u;   top8y1 = h;   rt6x3 = round(r — 1.25u);   top6y3 = h,
x2 = .5[x1, x3];   new w99;   w99 = round .75[w6, w8];   top99y2 = round .95h;
x0 = —.5u;   x4 = r + 1.5u;   y0 = y4 = 1.5h,                                 % arm
draw (|w8|0..)1..|w99|2..|w6|3(..4);
hpen;   x5 = x6 = x1;   top0y5 = h;   top0y6 = .75[e, m];
x7 = .5r;   top0y7 = m + oo;   x9 = x7 — .5u,   bot0y9 = —oo;
rt2x8 = round(r — u);   y8 = .5[y7, y9];                                    % stem
w0 draw 5..6;                                                 % left part of bowl
draw (9..)6..7{1, 0};                                        % right part of bowl
call `a arc(7, 8, w2);   call `b arc(9, 8, w2);
lft0x10 = lft3x11 = round u;   y10 = y11 = 1/3y6;                            % tail
w0 draw 9{—1, 0}..10{0, 1}                                                   % bulb
cpen;   w3 draw 11.

"Italic numeral 6";
% (Same as in the roman font, except for spacing.)
call charbegin(`6, 9, 0, 0, ph, pd, ph·slant — 5pu);
x1 = good2 1.5u;   x2 = good2(r — 1.5u);
new w99;   w99 = round .75[w0, w3];
cpen;   top3y3 = h — .25e,
if y3 < .5[m, h]:   new y3,   y3 = .5[m, h];
fi;
rt99x3 = rt0x4 = round(r — 1.5u);   y4 = y3;                                    % bulb
w99 draw 3;
hpen;   x20 = good2(x1 + .1u);   x5 = x6 = x10 = .5[x20, x2],   top0y5 = h + oo,
                                                                          % shoulder
w0 draw 4{0, 1}..5{—1, 0};
bot0y10 = —oo;   top0y6 = m + oo;   y20 = .5[y6, y10];
y7 = y2 = y10;   rt0x7 = rt2x20;                                              % bowl
call `a darc(6, 7, w0),   call `b darc(6, 2, w2);
new w99;   w99 = 2/3[w0, w2];           % intermediate width used in darc routine
x8 = x9;   rt99x8 = rt0(1/sqrttwo[x6, x7]);
y8 = 1/sqrttwo[y20, y7];   y5 — y9 = y8 — y7;   y1 = .5[y5, y10];
draw |w0#|5{—1, 0}..|w99|9{x7 — x6, y7 — y20}..|w2#|1{0, —1}               % stroke
        ..|w99|8{x8 — x7, y7 — y20}..|w0#|10{1, 0}.
```



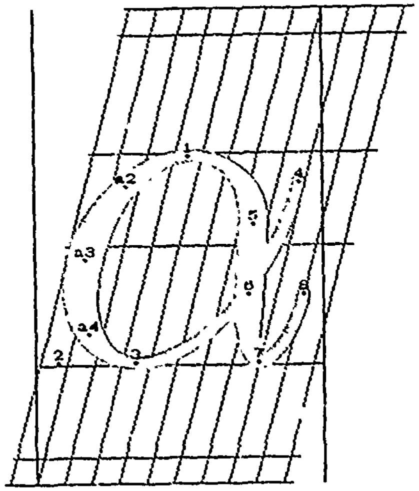


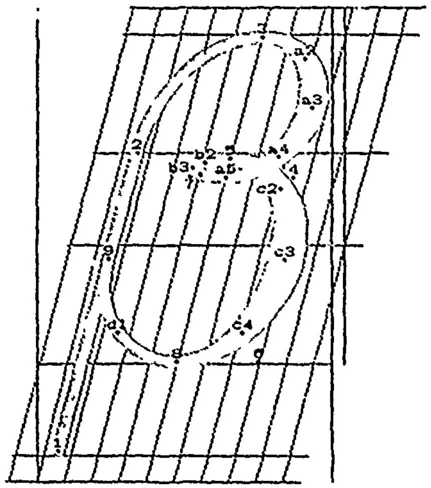
```
"Italic numeral 7";
call charbegin(`7, 9, 0, 0, ph, pd, ph·slant -- .5pu);
cpen;   x1 = good1 5.5u;   bot1y1 = --oo;   x2 = good0(r - u);   top0y2 = h,
x3 = good0.75u;   y3 = m;   y8 = good0.5[m,h];   y1 = y7 = y2;
(x4 - x1)/(y1 - y3) = (x2 - x1)/(y2 - y1);
top8y6 = top0y7;   bot8y6 = bot0y5;   x5 = x7 = 4u;   x8 = 2/3r;
w1 draw 1;                                                  % make end point round
hpen,   draw |w0#|2{2(x1 - x2), y1 - y2}   |w1#|1{0, -1};                   % stem
  0 draw 4..3;                                                            % serif
draw 8{1,0}..2{2(x2 - x1), y2 - y1};                                       % link
ddraw 3{x1 - x3, y1 - y3} .7{1,0}. 8{1,0},
     3{x1 - x3, y1 - y3}..5{1,0}..8{1,0}.                                   % bar

"Italic numeral 8";
% (Same as in the roman font, except for spacing.)
call charbegin(`8, 9, 0, 0, ph, pd, ph·slant - .5pu);
new w98, w99, ss;   w99 = round 1/3[w0, w1];
hpen;   lft99x1 = round u;   x2 = r - x1;   y1 = y2;
lft99x3 = round.75u;   x4 = r - x3;   y3 = y4;   x5 = r -  x5 = x6 = x7;
top0y5 = h + oo;   y6 = 52h;   bot0y7 = -oo,
w98 = 2[w7, w8];
if w0 = w98:   ss = 0;
else:   ss = h/(18u);                                                     % slope
fi;
call `a sdraw(5, 1, 6, 4, 7, w99, w98, --ss);       % upper left and lower right strokes
w99 draw 5{1,0}..2{0,-1}. 6{-1,--.75ss}..
     3{0,-1}..7{1 0}.                               % upper right and lower left strokes
```





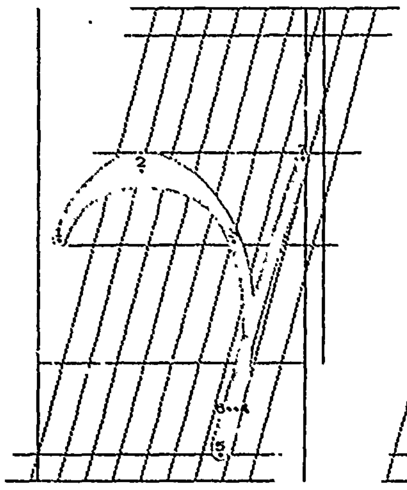
```
"Italic numeral 9",
% (Same as in the roman font, except for spacing.)
call charbegin('9, 9, 0, 0, ph, pd, ph slant — 5pu);
x1 = good2(r — 1.5u);   x2 = good2 1.5u;
new w99;   w99 = round .75[w0, w3],
cpen;   bot99y1 = 25e;
if y1 > 5e:   new y1;   y1 = .5e;
fi;
lft99x3 = lft0x1 = round 1.5u;   y1 = y3;
w99 draw 3;                                                            % bulb
hpen;   x20 = good2(x1 — .1u);   x5 = x6 = x10 = 5[x20, x2],   bot0y5 = —oo;
w0 draw 4{0, —1}..5{1, 0};                                            % tail
top0y2 = h + oo;   y6 = e — oo,   y20 = 5[y2, y6],
y7 = y10 = y2;   lft0x7 = lft2x20;
call `a darc(6, 7, w0);   call `b darc(6, 2, w2);                    % bowl
new w99;   w99 = ⅓[w0, w2];                   % intermediate width in darc routine
x8 = x9;   lft99x9 = lft0(1/sqrttwo[x6, x7]);
y8 = 1/sqrttwo[y20, y7];   y9 — y6 = y8 — y7,   y4 = 5[y5, y10];
draw |w0#|5{1, 0}..|w99|9{x7 — x6, y7 — y20}..|w2#|1{0, 1}
     ..|w99|8{x6 — x7, y7 — y20}..|w0#|10{—1, 0}                     % stroke

"Italic question mark";
call charbegin('077, 9, 0, 0, ph, 0, 0),
cpen;   lft3x1 = lft0x2 = round u;   y1 = y2;   bot1y1 = m,
x3 = x4 = x6 = x8 = .5r;   top0y3 = h + oo;   y8 = 5h;   y6 = good0 ⅔e,
rt10x9 = round(r — 1.5u);   lft10x7 = round 3u;
x5 = ⅓r;   top0y5 = e;   bot1y4 = 0;
w1 draw 4;                                                             % dot
draw 1;                                                                % bulb
hpen;   w0 draw 2{0, 1}..3{1, 0},                                      % shoulder
call `a sdraw(3, 9, 8, 7, 6, w10, w8, (y3 — y6)/(10u));                % stroke
draw 6{1, 0}..5{0, 1}.                                                 % point
```

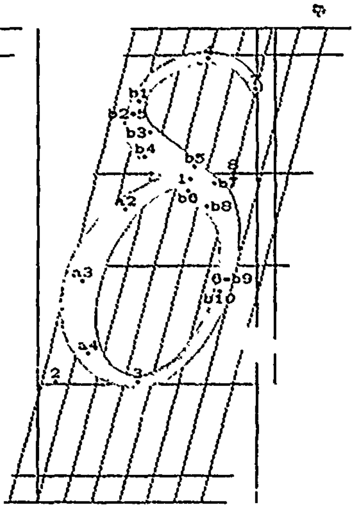


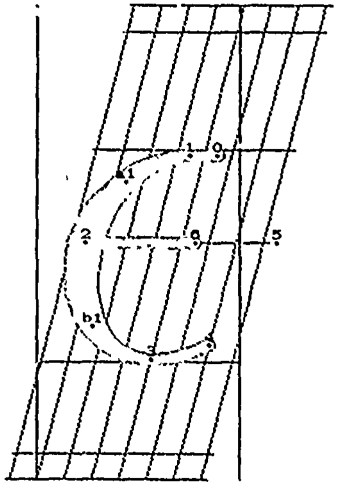


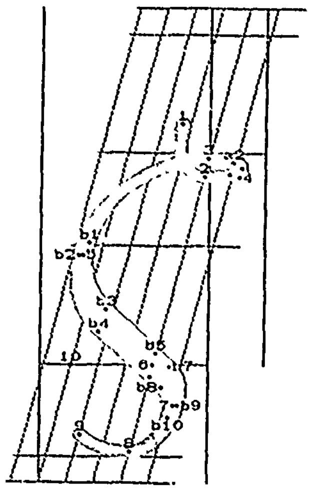
T: e file greek1 mf

```
% This lowet-case Greek alphabet was prepared by D. E. Knuth in December, 1979,
% inspired by the Monotype alphabet used in The Art of Computer Programming
% Its spacing is intended for math formulas only.
% Character codes '013-'037 and '173-'177 are used.
new mc, lbowl, lhook, rbowl, rhook, rstem;                % quantities used in spacing corrections
mc = 1/pu;
rhook = ⅓px·slant + .5pw + 5pu;
lbowl = .3px·slant − .5pwii + pu;
rbowl = .7px·slant + .5pwii − pu;
lhook = ⅔px·slant − 5pw − 5pu;
rstem = px·slant + 5pwi − pu;

"Lower case Greek alpha";
call charbegin('013, 10, mc·lbowl, −mc rhook, px, 0, 0),
hpen;  x1 = x3 = 4.5u;  lft2x2 = round u;
top0y1 = m + oo;  bot0y3 = −oo,  y2 = y3.                                       % left of bowl
call 'a darc(1, 2, w2);
rt0x4 = round(r − u),  top0y4 = .75[c, m];                                      % upper diagonal
w0 draw 3{1, 0} . . 4{0, 1};
x5 = r − 2.5u;  x6 = r − 2u,  y5 = ⅔m;  y6 = ⅓m;
bot0y7 = −oo;  x7 = r − u;  x8 = good0r;  y8 = y6;
draw |w0#|1{1, 0} . . |w1#|5{x6 − x5, y6 − y5} . .                              % lower diagonal and tail
     |w1#|6{x6 − x5, y6 − y5} . . |w0#|7{1, 0} . . 8{0, 1}

"Lower case Greek beta";
call charbegin('011, 9 5, mc(pu − pd·slant − 5pw),
                 −mc·rbowl, ph, pd, 5[px, ph]·slant − pu − rbowl),
hpen;  x1 = x2 = x9 = good0 1.5u;  bot0y1 = −d;  y2 = m;
x3 = x5 = x8 = 5u;  rt1x4 = round(r − 1 5u);
x6 = good1(r − 1.5u);  lft0x7 = round 3.5u;
top0y3 = h + oo;  bot0y4 = m − w1;  top0y5 = m;  bot0y6 = −oo,  y4 = y7,  y6 = y8,
y9 = .5m;                                                                       % stem and shoulder
w0 draw 1  2{0, 1} . 3{1, 0};                                                   % upper bowl
call 'a darc(3, 4, w1);                                                         % loop
call 'b darc(5, 7, w0);                                                         % lower bowl
call 'c darc(5, 6, w2);                                                         % link
call 'd arc(8, 9, w0).
```

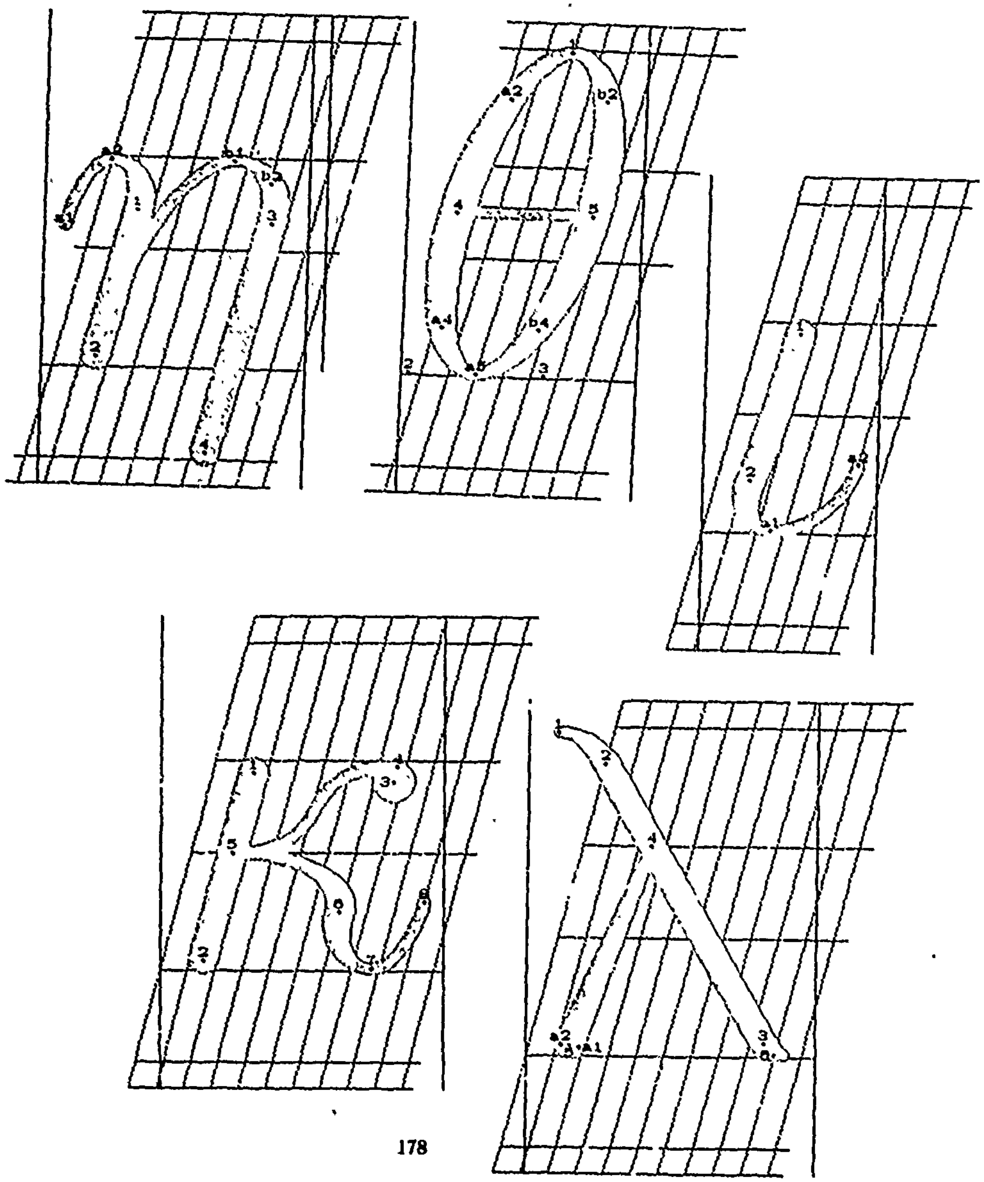




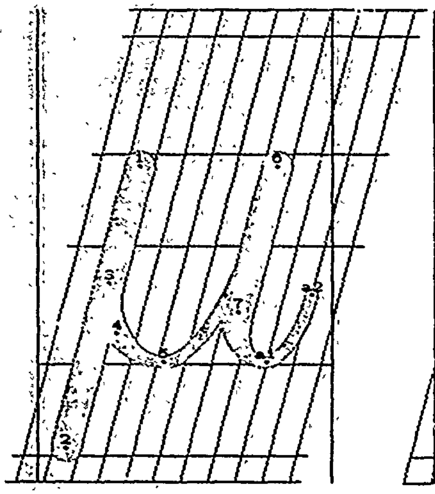


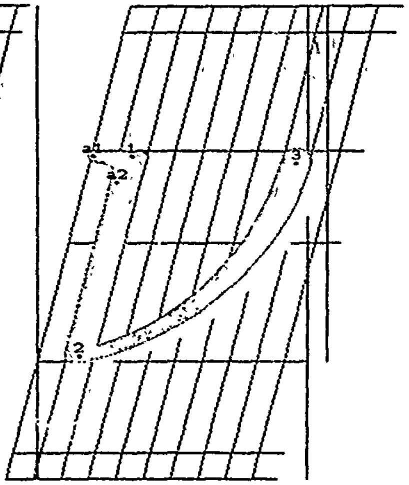


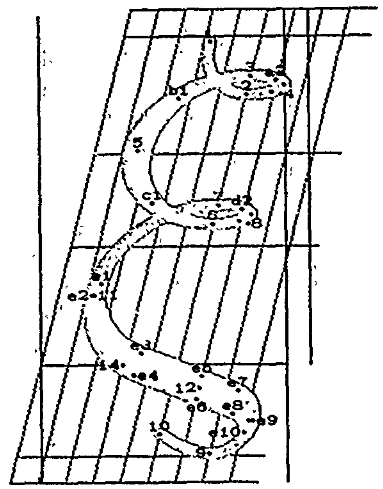
```
"Lower case Greek gamma",
call charbegin('015, 10, mc pe·slant, --mc(½px·slant -- 5pu), px, pd, ⅓px slant);
vpen;   lft6x1 == round .5u;   bot6y1 = e,   top8y2 = m,   x2 == 3u;
x3 == 1/sq.ttwo[x2, x1];   y3 = 1/sqrttwo[y1, y2],
rt6x4 = round(r -- u);   y4 = -- 5d,   x5 = 5[x4, x6],   bot6y5 = --d -- o,
lft6x6 = round(r   u -- ½[w6, w4]),   y6 = y4,   x7 = x4;   top0y7 = m;
draw |w6#|1{0, 1}..|w8#|2{1, 0}   |w6#|3{x1 -- x2, y1 -- y2}   4{0, -- 1}
     5{--1, 0}   6{0, 1}.  7{2(x7 -  x6), y7 -- y6}                          % stroke

"Lower case Greek delta";
call charbegin('016, 8, mc lbowl, --mc( 7px slant -- 5pu), ph, 0,
                     9ph slant + 5pw - 1 5pu - ( 7px slant -  5pu)),
hpen;   x1 == 4.5u;   top0y1 == m,   x2 = good2 1 5u,   y2 -= y3;
x4 == x1;   bot0y3 == --oo;   x4 == 4u,   top0y4 -- h + oo,
lft11x5 == round(1 5u);   rt11x6 = round(r -- u);
x7 == x8 == r -- 2u,   y7 = .9h;   y8 == m,
call `a darc(1, 2, w2);                                             % left of bowl
call `b sdraw(4, 5, 1, 6, 3, w11, w8, --h/(18u));       % shoulder and right of bowl
w0 draw 4{1, 0}..7(..8).                                                  % point

"Lower case Greek epsilon";
call max(px slant + .5pw -- 2pu, -- 5pu);
call charbegin('017, 8, mc·lbowl, --mc arc, px, 0, 0);
hpen;   x0 -- .5u == x3 == r -- 3u;   x1 =  5(r + u),   top0y1 = m,   y0 = y1,   x6 = x0,
x2 == good2 1.5u;   y2 == y5 == y6 == e,   x4 == r -- u;   x5 == r + 5u;   bot0y4   --oo,
new aa;   x4 = aa[x6, x5];   y4 == (sqrt(1 -- aa·aa))[y6, y3],
w0 draw 0..1;                                                % strengthen upper point
call `a arc(1, 2, w2);                                          % upper left of bowl
call `b arc(3, 2, w2);                                          % lower left of bowl
draw 3{1, 0}..4(   5);                                               % lower point
draw 2..6.                                                                 % bar

"Lower case Greek zeta",
call charbegin('020, 7, mc lbowl, 0, 25[px, ph], pd, px slant),
hpen;   lft0x1 = round 3 5u;   y1 =  25[m, h];
x2 == x3 == x8 == x9 == 5u;   bot0y2 == m -  w2,   y2 = y1,   top0y1 == m;
rt0x4 == round(r --  5u),   lft10x,  · round u,   y5   0;   rt10x,   round(r    5u),
bot0y8 == --d;   x9 -  3u;   x10 -- 2u,   y9 --    75d,   y10 - 0,
w1 draw 1{0, --1}   2{1, 0},                                           % flourish
call `a darc(3, 4, w0);                                                    % loop
call `b sdraw(3, 5, 6, 7, 8, w10, w8,   r/(6u)),                         % stroke
draw 8{--1, 0}   9(..10)                                                  % point
```

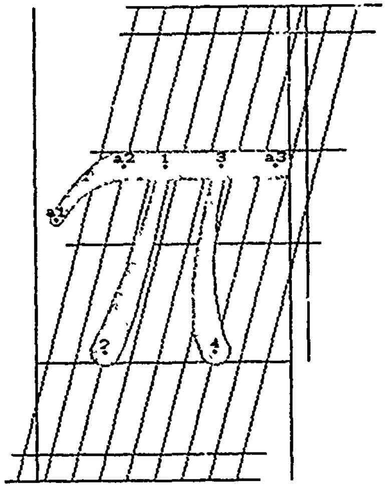


```
Lower case Greek eta";
call charbegi‵'021, 10, mc·lhook, —mc(rstem — ⅔px slant), px, pd, ⅓px slant);
x1 = good1 2  u;   call ˋa entry(0, 1);                                       % opening hook
cpen;   x2 = x1;   bot1y2 = —oo;   w1 draw 1 . 2;                                   % left stem
x3 = good1(r — 2.5u);   call ˋb itallhstroke(2, 3);                                % shoulder
x4 = x3;   bot1y    —d — o;   draw 3 . . 4.                                       % right stem

"Lower case Greek theta";
call charbegin('022, 8, mc( 3ph·slant + pu — .5pwit),
                  —mc(.7ph·slant — pu + 5pwit), ph, 0, 0);
x1 = r - x1;                                                   % axis of left-right symmetry
x2 = x1 = good2 1.5u;   x4 = x5 = r — x1,
top0y1 = h + oo;   bot0y2 = —oo;   y4 = y5;   y1 = y5 =  5[y1, y2];
call ˋa darc(1, 2, w2);                                                % left part of bowl
call ˋb darc(1, 3, w2);                                               % right part of bowl
w0 draw 4 . . 5.                                                                   % bar

"Lower case Greek iota";
call charbegin('023, 5, 0, —mc·rhook, px, 0, 0);
cpen;   x1 = good1 1.5u;   x2 = x1 — 25u;   top1y1 = m + oo,
call ˋa skewexit(2, r);                                                    % closing hook
w1 draw 1{0, —1}  . 2{—u, —m}                                                      % stem

"Lower case Greek kappa";
call charbegin('024, 9, 0, —mc·rhook, px, 0, 0);
cpen;   x1 = x2 = x3 = good1 1 5u;   top1y1 = m + oo;   bot1y2 = —oo;
top1y3 = top0y1 = m;   x4 = x1;   rt1x4 = round(r — 1 5u);
y5 = c,   x6 = 6u,   x7 = 7.75u;   x8 = good0r;
y6 = 5e;   bot0y7 = —oo,   y8 = ⅓m;
w1 draw 1  . 2;                                                                    % stem
w2 draw 3;                                                                         % bulb
hpen;   w0 draw 5{1, 0}  . 4{1, 0},                                      % upper diagonal
draw |w0#|5{1, 0} .  |w1#|6{0, —1}   |w0#|7{1, 0}   8{0, 1}               % lower diagonal

"Lower case Greek lambda";
call charbegin('025, 10 5, 0, 0, ph, 0, 0);
cpen;   top0y1 = h;   x1 = —2u,   x2 = 0,   y2 = 7[m, h],   x4 = r   2u,   y4 = 125e.
new aa;   x1   - aa[x2, x1],   y1 = aa[y2, y1],   y1 = m,   x4 — 1 5u,   bot1y4 —   oo,
hpen;   x6 = r — 1.5u,   bot1y6 = —oo;
draw |w0#|1{1, 0}   |w1#|2{x1 — x2, y1 — y2}   3{x4 — x2, y4 — y2}
     6{2(x6 — x1), y6 — y1},                                              % long diagonal
call ˋa cdraw(5, 4, 1, 0)                                                 % short diagonal
```

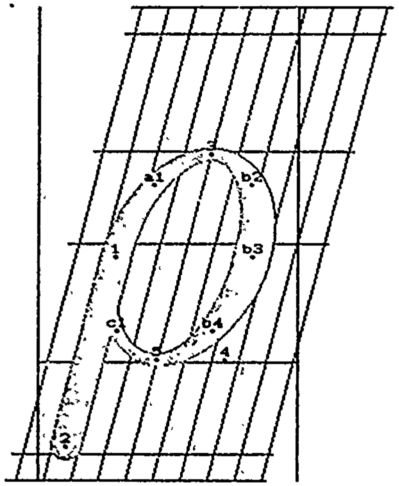


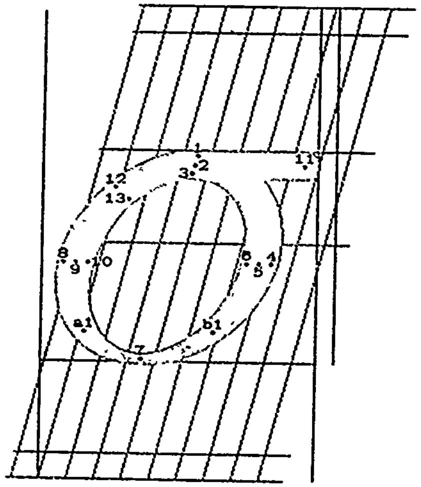


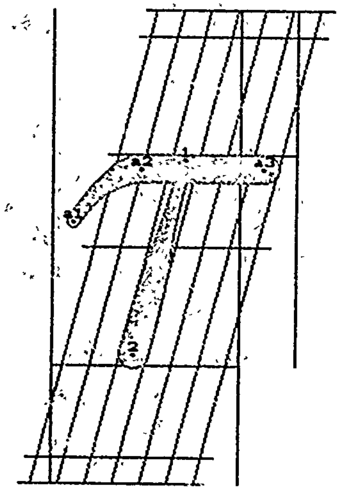


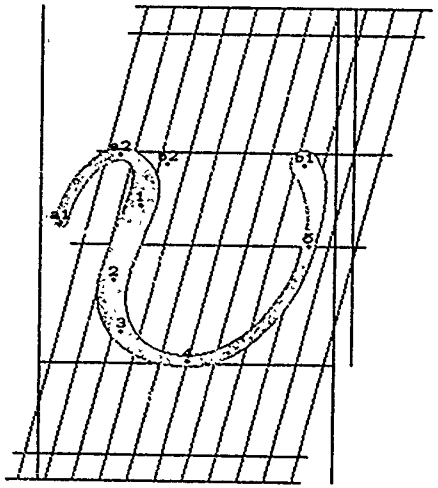


```
"Lower case Greek mu";
call charbegin('026, 9, mc(pu — pd·slant — .5pwi), —mc·rhook, px, pd, 0);
cpen;   x1 = x2 = x3 = good1 1.5u;
x1 = x1 + .75u;   x5 = .55[x1, x6];   x6 = x7 = good1 6.5u;
top1y1 = m + oo;   bot1y2 = —d — o;   y3 = .7e;   y1 = .25[y5, e];   bot0y5 = —oo;
y6 = y1;                                                              % closing hook
call ˆa exit(7, r);                                                          % stems
w1 draw 1..2;   draw 6..7;                                                   % stroke
hpen;   draw |w1#|3{0, —1}..|.75[w0, w1]|4   |w0#|5{1, 0} . 6{0, 1}.

"Lower case Greek nu";
call charbegin('027, 9, 0, —mc(rstem -- ½px·slant), px, 0, ½px·slant);
cpen;   x1 = x2 = good1 1.5u;   x3 = r — 1.5u;
top0y1 = m;   bot0y2 = 0;   top1y3 = m + oo;                                  % stem
hpen;   w1 draw 1..2;                                                          % serif
call ˆa serif(1, 1, 2, —lcs);                                  % erase excess at bottom
rpen#;   w1 draw 2{36u m} .3{0, 1};                                             % bulb
cpen;   w1 draw 3;                                                          % diagonal
hpen;   draw |w0|2{36u, m}..|w1#|3{0, 1}.

"Lower case Greek xi";
call charbegin('030, 9, 0, 0, ph, pd, .75[px, ph]·slant -- 2pu);
hpen;   top0y1 = h;   lft0x1 = round 3u;
x2 = x3 = 5u;   bot0y2 = top0y3 — w7;   top0y1 = round(y1 — .25(h — m)),   y1 = y2;
rt0x1 = round x2 + 1.5u;   lft1x5 = round u;   y5 = .5[y1, y6];
x6 = x7 = 5u;   bot0y6 = top0y7 — w7;   top0y7 = round 5h;   y8 = y6;
rt0x8 = round x6 + 1.5u;
lft10x11 = round u;   x12 = r — 3u;   y12 = — ½d;   rt10x11 = round(r — 5u);
x9 = r — 2u;   bot0y9 = —d — oo;   x10 = x9 — 2u;   y10 = — 75d,   x11 = x10 -- 2u;
y11 = 0;                                                                   % flourish
w0 draw 1{0, —1}..2{1, 0};                                             % upper loop
call ˆa darc(3, 4, w0);                                                % top of bowl
call ˆb arc(3, 5, w1);                                              % bottom of bowl
call ˆc arc(6, 5, w1);                                                  % lower loop
call ˆd darc(7, 8, w0);                                                     % stroke
call ˆe sdraw(7, 11, 12, 13, 9, w10, w8, -- c/(12u));                        % point
draw 9{—1, 0}..10(..14).

"Lower case Greek pi";
call charbegin('031, 9, mc(7px slant — 5pw — 5pu),
                 —mc(⅔px·slant -- pu + .5pwi·aspect), px, 0, ½px·slant);
                                                                               % bar
call ˆa pistroke;
cpen;   bot1y2 = —oo;   top7y1 = m;   y3 = y1;   y1 = y2;
x1 = good0 3.5u;   x2 = good1 3u,   x3 = good0 5.5u;   x4 = good1 7u,
hpen;   draw |w0#|1{0, —1}..|w1#|2{3.14159(x2 — x1), y2 — y1};           % left stem
draw |w0#|3{0, —1}..|w1#|4{3 14159(x4 — x3), y4 — y3},                 % right stem
cpen;   w1 draw 2;   draw 4.                               % make the end points round
```

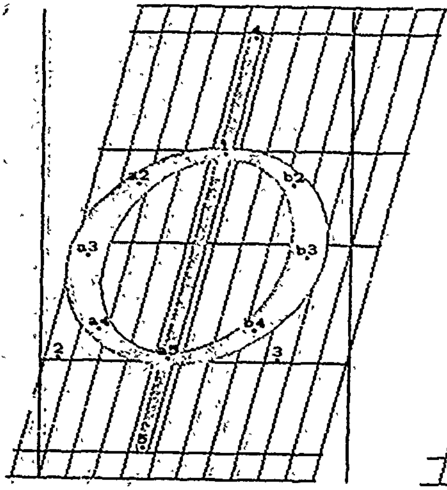


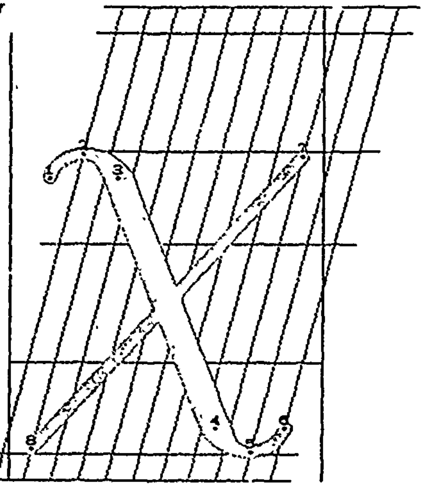


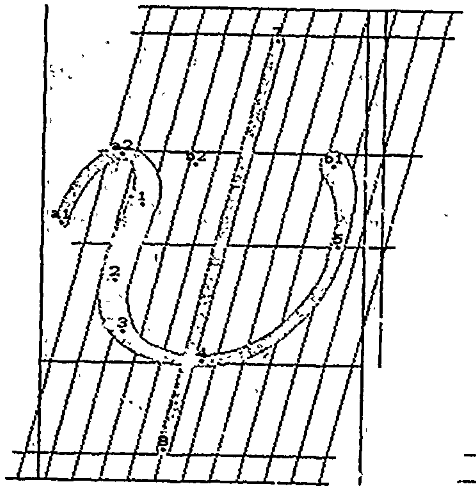


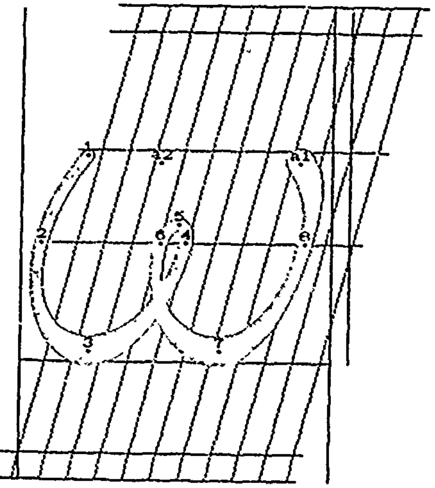


```
"Lower case Greek rho";
call charbegin('032, 8, mc(pu − pd·slant − .5pwi), −mc·rbowl, px, pd, 0);
cpen;   x1 = x2 = good1 1.5u;   x1 = good2(r − 1.5u);   x3 = x5 = 5[x1, x1];
bot1y2 = −d − o;   y1 = .5[y1, y5];   top6y3 = m + oo;   bot6y5 = −oo;   y1 = y5;
w1 draw 2..1;                                                   % stem
call `a arc(3, 1, w1);                           % upper left part of bowl
call `b darc(3, 4, w2);                               % right part of bowl
call `c arc(5, 1, w0).                           % lower left part of bowl

"Lower case Greek sigma";
call charbegin('033, 10, mc ibowl, −mc(⅔px·slant − 5pu), px, 0, ⅓px·slant);
cpen;   top7y7 = top6y1 = m;   bot7y2 = bot6y3;   y11 = y2;
y8 = y9 = y10 = y6 = y5 = y1 = .5[y2, y7];   bot0y7 = −oo;
x1 = x2 = x3 = x7 = .5(r − u),   rt7x11 = r − u;
lft0x8 = lft2x9 = round 5u,   rt0x10 = rt2x9;
lft0x6 = lft2x5;   rt0x1 = rt2x5 = round(r − 1.5u);
x12 = 1/sqrttwo[x1, x8];   y12 = 1/sqrttwo[y8, y1];
x13 = 1/sqrttwo[x3, x10];   y13 = 1/sqrttwo[y10, y3];
w7 draw 2..11;                                                   % bar
hpen;   w0 ddraw 8{0, 1}. 12{x1 − x8, y1 − y8}..1{1, 0}. 4{0, −1},
     10{0, 1}..13{x3 − x10, y3 − y10} .3{1, 0}..6{0, −1};  % upper part of bowl
call `a arc(7, 9, w2);                           % lower left part of bowl
call `b arc(7, 5, w2).                          % lower right part of bowl

"Lower case Greek tau";
call charbegin('034, 8, mc(.7px·slant − 5pw − .5pu) 5
     px, 0, px·slant − .5pu + .5pwi·aspect);
call `a pistroke;                                                % bar
cpen;   x1 = x2 = good1 3.5u;   top0y1 = m;   bot1y2 = −oo;
w1 draw 2;                                 % make lower end point round
hpen;   draw |w0#|1..|w1#|2.                                    % stem

"Lower case Greek upsilon";
call charbegin('035, 10, mc·lhook, −⅔mc·px·slant, px, 0, ⅓px·slant);
x2 = good1 2.5u;   x1 = x2 + .25u;   x3 = x2 + .8u;
call `a skewentry(0, 1);                                 % opening hook
hpen;   y2 = .7[y1, e];   y3 = .25[y1, e];   bot0y4 = −oo;   x4 = 6u;
rt0x5 = round(r − .5u);   y5 = e;
draw |w1|1{−u, −m}..|w1#|2{0, −1}..|.75[w0, w1]|3..
     |w0#|4{1, 0}..5{0, 1};                                   % stroke
call `b endv(5).                                         % closing bulb
```

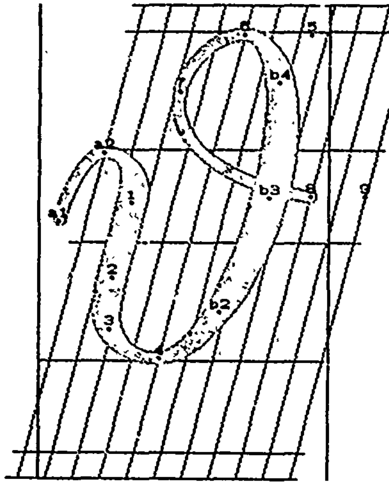


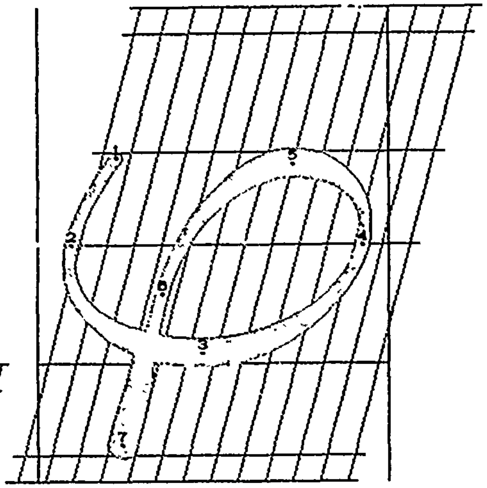


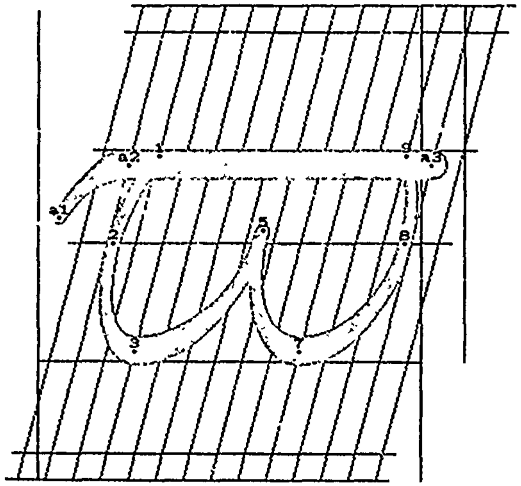




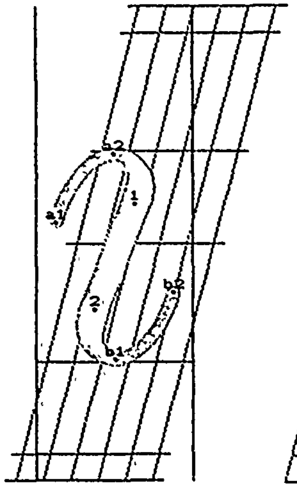
```
"Lower case Greek phi";
call charbegin('036, 11, mc·lbowl, −mc·rbowl, ph, pd, 0);
x1 = r − x1;                                              % axis of left-right symmetry
x2 = good2 1.5u;   x3 = r − x2;
hpen;   top0y1 = m + oo;   bot0y2 = −oo;   y3 = y2;
top0y4 = h;   bot0y5 = −d;   x4 = x5 = x1;
call `a darc(1, 2, w2);                                        % left half of bowl
call `b darc(1, 3, w2);                                       % right half of bowl
w0 draw 4..5.                                                            % stem

"Lower case Greek chi";
if (px + pd)·slant > 2pu:
     call charbegin('037, 11, mc(1.5pu − pd·slant − .5pw),
                         −mc(px·slant + .5pw − 1.5pu), px, pd, 0),
else.   call charbegin('037, 11, mc(px·slant − .5pw − .5pu),
                       −mc(.5pu − pd·slant + .5pw), px, pd, 0);
fi;
hpen;   x1 = good0 0;   x2 = u;   x3 = 2.5u;   x4 = r − x3;   x5 = r − x2,   x6 = r − x1;
x7 = good0(r − 2u);   x8 = r − x7;
y1 = y3 = .875m;   top0y2 = m + oo,   bot0y5 = −d − oo;   y2 − y1 = y4 − y5;   y4 = y6;
top0y7 = m;   bot0y8 = −d;
draw |w0|1{0, 1}..|w0#|2{1, 0}   |w1#|3{x4 − x3, y4 − y3}   |w1#|4{x4 − x3, y4 − y3}
     |w0#|5{1, 0}..6{0, 1};                          % upper left to lower right diagonal
w0 draw 7..8.                                        % upper right to lower left diagonal

"Lower case Greek psi";
call charbegin('173, 11, mc·lhook, −⅔mc·px·slant, ph, pd, ⅓px·slant);
x2 = good1 2.5u;   x1 = x2 + .25u;   x3 = x2 + 8u;
call `a skewentry(0, 1),                                              % opening hook
hpen;   y2 = .7[y1, e];   y3 = .25[y1, e];   bot0y4 = −oo;   x4 = 6.5u;
rt0x5 = round(r − .5u);   y5 = e;
draw |w1|1{−u, −m}..|w1#|2{0, −1}..|.75[w0, w1]|3..
     |w0#|4{1, 0}..5{0, 1};                                                 % stroke
call `b endv(5);                                                       % closing bulb
x7 = x8 = .5(r + u);   top0y7 = h,   bot0y8 = −d;   w0 draw 7..8.             % stem

"Lower case Greek omega";
call charbegin('174, 11, mc·pe·slant, −⅔mc·px·slant, px, 0, ⅓px·slant);
hpen;   x1 = good0 1.5u;   lft0x2 = round .5u;   x3 = 3.5u,   x5 = good1 .5r;
rt0x4 = rt1x5;   lft0x6 = lft1x5;   x7 = r − 2.75u;   rt0x8 = round(r − .5u);
vpen;   top0y1 = m;   y2 = y4 = y6 = y8 = e,   bot1y3 = −oo;   y5 = good0 .2[e, m],
y7 = y3;
draw |w0|1{2(x2 − x1), y2 − y1}   |w0#|2{0, −1}   |w1#|3{1, 0}   |w0#|4{0, 1}..
     5{−1, 0}..|w0#|6{0, −1}..|w1#|7{1, 0}..|w0#|8{0, 1},                    % strokes
call `a endv(8).                                                       % closing bulb
```

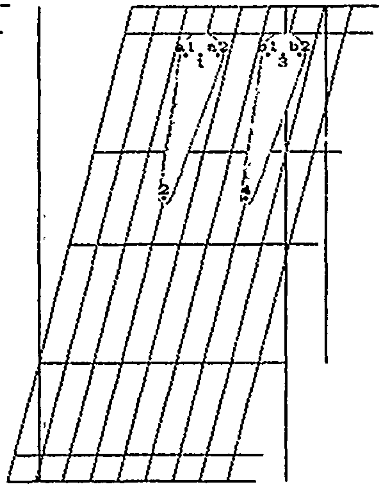


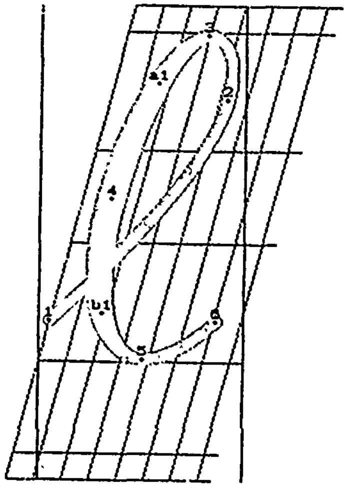




```
"Variant lower case Greek phi";
call charbegin('175, 12, .3mc·px·slant, —.7mc·px·slant, ph, pd, 0);
hpen;   x1 = good0 1.5u;   lft0x2 = round .5u;   x3 = .5(r + u);
rt0x1 = round(r — .5u);   x5 = 8u;   x0 = x7 = good0 4.5u;
vpen;   top6y1 = m;   y2 = y1 = e;   bot7y3 = —oo;   top7y5 = m + oo;   y6 = ¼m;
bot1y7 = —d — oo;
draw |w6|1{2(x2 — x1), y2 — y1}..|w6#|2{0, —1}..|w7#|3{1, 0}..|w6#|4{0, 1}.
     |w7#|5{—1, 0}..|w6#|6{0, —1};                                    % stroke
hpen;   draw |w0#|6..|w1#|7;                                            % stem
cpen;   w1 draw 7.                                       % make the end point round

"Variant lower case Greek theta";
call charbegin('176, 9, mc·lhook, —mc(.5[pe, px]·slant + .5pw + .5pu), ph, 0, 0);
x1 = = good1 2.5u;   call `a entry(0, 1);                          % opening hook
hpen;   x2 = x1;   y2 = .7[y1, e];   x1 = x2 + .4u;   y1 = .25[y1, e];
x1 = .5[x1, x5];   bot0y1 = —oo;   x5 = good2(r — 1.5u);   top0y5 = h + oo;
x6 = x1;   y6 = y5;   lft0x7 = round 3u;   y7 = .5[m, h];
x8 = r;   y8 = y9 = good0 5[e, m];   x9 = r + 2u;
draw |w1|1..|w1#|2{0, —1}..| 75[w0, w1]|3..|w0#|4{1, 0};     % lower left part of bowl
call `b darc(4, 5, w2);                                        % right part of bowl
w0 draw 6{—1, 0}..7{0, —1}..8(..9).                                     % ioop

"Variant lower case Greek omega";
call charbegin('177, 14.5, mc(.7px·slant — 5pw — .5pu), 0,
                      px, 0, px slant — pu + 5pwi·aspect);
call `a pistroke;                                                          % bar
hpen;   x1 = good0 3u;   lft0x2 = round 2u;   x3 = 4u;   x5 = good2 7 5u;
x7 = r — 4 5u;   rt0x8 = round(r — 1.5u);   x9 = r — 2.5u;
vpen;   top0y1 = m;   y2 = y8 = e,   bot7y3 = —oo;   y7 = y3,   y9 = y1;   bot1y5 = e;
draw |w6|1{2(x2 — x1), y2 — y1}..|w6#|2{0, —1}..|w7#|3{1, 0} .
     |w6#|5{0, 1};                                                     % left bowl
draw |w6#|5{0, —1}. |w7#|7{1, 0}..|w6#|8{0, 1}..
     9{2(x9 — x8), y9 — y8}.                                          % right bowl
```

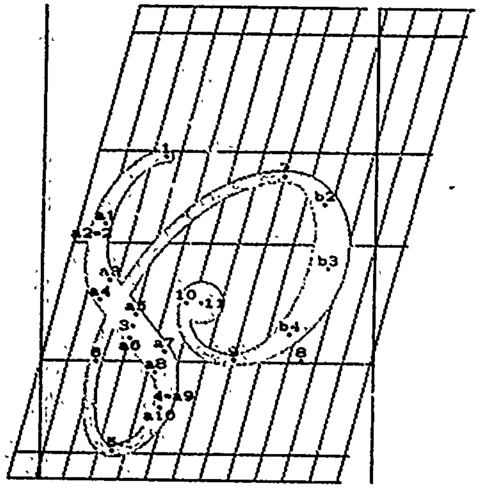


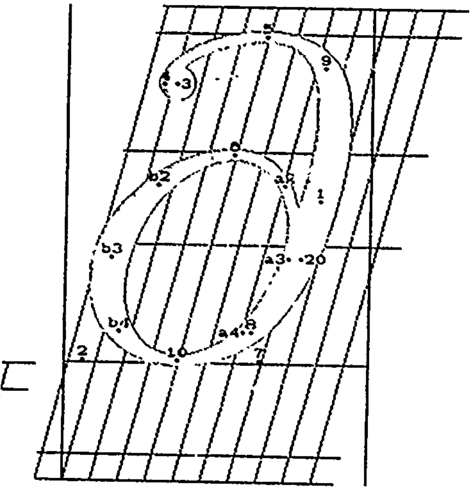


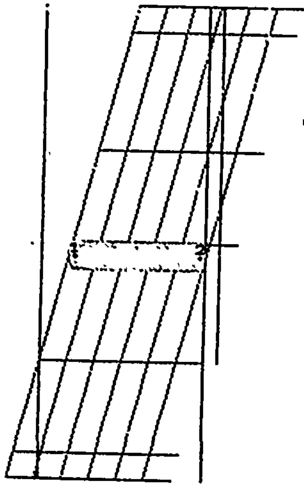


The file italms.mf

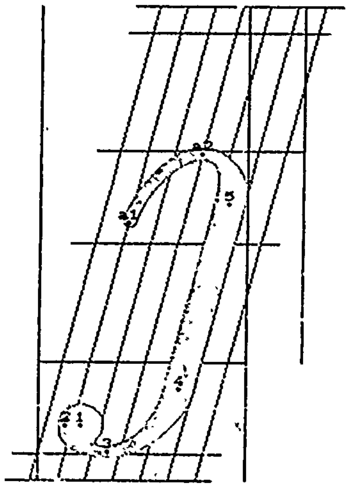
```
% This file contains miscellaneous symbols of math italic fonts
% Math spacing is assumed.
% The character codes are ´040, ´042-´045, ´055, and ´100.

new mc, lbowl, lhook, rbowl, rhook, rstem;          % quantities used in spacing corrections
mc = 1/pu;
rhook = ¼px slant + .5pw + .5pu;
lbowl = .3px·slant − .5pwii + pu;
rbowl = .7px·slant + .5pwii − pu;
lhook = ⅔px·slant − .5pw − .5pu;
rstem = px·slant + .5pwi − pu,

"Dotless italic letter i";
call charbegin(´040, 7, 1 + mc·lhook, 1 − mc·rhook, px, 0, 0);
x1 = .5r + .25u;   x2 = .5r − .25u;
call `a skewentry(u, 1);                                          % opening hook
call `b skewexit(2, r − u);                                       % closing hook
hpen;   w1 draw 1..2.                                                     % stem

"Straight double quotes";
call charbegin(´042, 9, 0, 0, ph, 0, ph·slant + .5pwiii − 2.5pu);
new w99;
if w3 < w0 sqrt 2:   w99 = round w0 sqrt 2;
else:   w99 = w3;
fi;
x1 = x2 = good99 3u;   x3 = x4 = r − x1;
cpen;   top99y1 = h;   y2 = .5[e, m],   y3 = y1;   y4 = y2;
call `a cdraw(1, 2, 99, 0);                                           % left stem
call `b cdraw(3, 4, 99, 0).                                          % right stem

"Lower case italic script l";
call charbegin(´043, 6, 0, −mc(.8ph·slant − pu), ph, 0, 0);
hpen;   x1 = good0 0;   rt0x2 = round(r − 1.5u);   x3 = .5r;   lft1x4 = round .5u;
x5 = r − 2.25u;   x6 = good0(r + 2);                      % (two in a row will connect)
y1 = y6 = .125h;   y2 = .8h,   top0y3 = h + oo;   y4 = .5[y3, y5];   bot0y5 = −oo;
w0 draw 1{10u, h}..2{0, 1}..3{−1, 0};                             % right of bowl
call `a arc(3, 4, w1);   call `b arc(5, 4, w1);                    % left of bowl
draw 5{1, 0}..6{10u, h}.                                                   % link
```

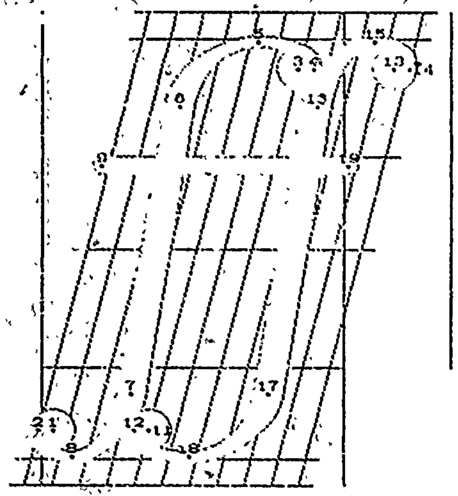


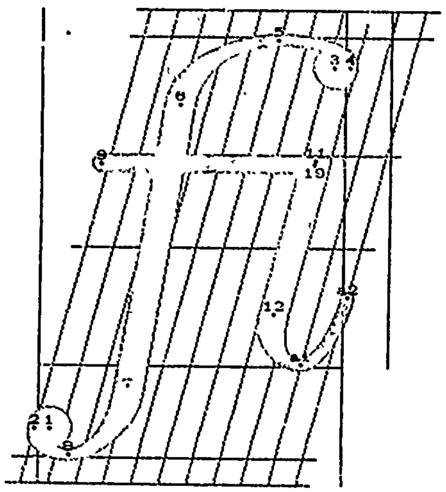




```
"Weierstrass p";
call charbegin('044, 11, 0, -mc·rbowl, px, pd, 0);
hpen;   x1 = 2.5u;   top0y1 = m;   lft10x2 = round .5u;
x3 = 3u;   y3 = .5[e, -.5d];   rt10x4 = round 5 25u;
x5 = 3.5u;   bot0y5 = -d -- oo;
call `a sdraw(1, 2, 3, 4, 5, w10, w8, -m/(8u));                % flourish
x6 = good0 2u;   y6 = 0;   x7 = 7u;   top0y7 = round .8[e, m];
w0 draw 5{-1, 0} .. 6{0, 1} .. 7{1, 0};                    % stem and shoulder
x8 = good2(r - 1.5u);   bot0y8 = -oo;   x9 = x7;   y9 = y8;
call `b darc(7, 8, w2);                                        % bowl
lft1x11 = lft0x10 = round 4.5u;   y10 = y11 = .5e;
draw 9{-1, 0} .. 10{0, 1};                                     % link
cpen,   w3 draw 11.                                            % bulb

"Partial differential sign";
call charbegin('045, 10, mc·lbowl, -mc(.7ph·slant + .5pwii - pu), ph, 0, 0);
% (This is a mirror-reflected number 6, one unit wider )
x1 = good2(r - 1.5u);   x2 = good2 1.5u;
new w99;   w99 = round .75[w0, w3];
cpen;   top3y1 = h - .25e;
if y1 < 5[m, h]:   new y1;   y1 = .5[m, h];
fi;
lft99x3 = lft0x1 = round 1.5u;   y1 = y3;
w99 draw 3;                                                    % bulb
hpen;   x20 = good2(x1 - 1u);   x5 = x6 = x10 = .5[x20, x2];   top0y5 = h + oo;
w0 draw 4{0, 1} .. 5{1, 0};                                    % shoulder
bot0y2 = --oo;   top0y6 = m + oo;   y20 = .5[y2, y6];
y7 = y2 = y10;   lft0x7 = lft2x20;
call `a darc(6, 7, w0);   call `b darc(6, 2, w2);              % bowl
new w99;   w99 = 2/3[w0, w2];        % intermediate width used in darc routine
x8 = x9;   lft99x8 = lft0(1/sqrttwo[x6, x7]);
y8 = 1/sqrttwo[y20, y7];   y5 -- y9 = y8 -- y7;   y1 = 5[y5, y10];
draw |w0#|5{1, 0} . |w99|9{x7 - x6, y7 - y20} .. |w2#|1{0, --1}
      .. |w99|8{x6 - x7, y7 - y20} .. |w0#|10{-1, 0}.          % stroke

"Hyphen";
call charbegin('055, 6, 0, 0, px, 0, 5px·slant -- .5pu);
vpen;   y1 = y2 = .5m;
if fixwidth = 0:   lft7x1 = 0;   rt7x2 = r -- u;
else:   lft7x1 = 1.5u;   x2 = r -- x1;
fi;
w7 draw 1 .. 2.                                                % bar
```



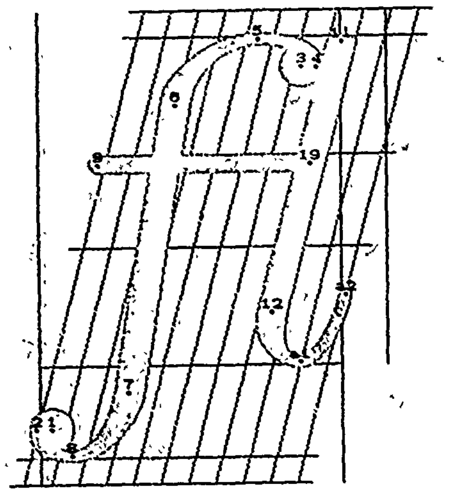


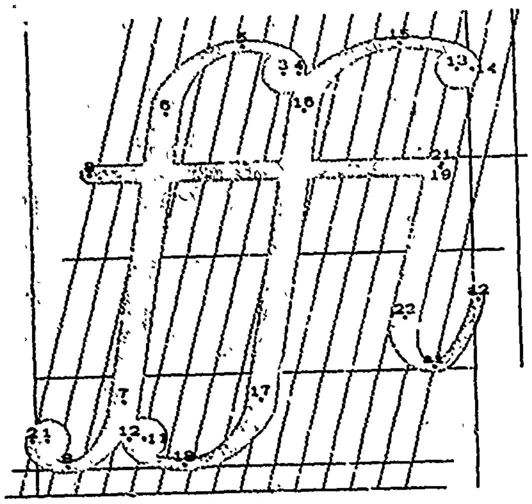


```
"Dotless italic letter j";
call charbegin('100,7.5,1 - mc(pu + pd·slant),1 - mc(pe·slant + .5pwi - 1.5pu),
      ph,pd,(ph - pe)·slant);
cpen;  lft3x1 = lft0x2 = round .5u;  x3 = 2.5u;  x4 = x5 = good1 4.5u;
bot3y1 = -.9d;  y2 = y1;  bot6y3 = -d - oo,  bot6y4 = -1/3d;
w3 draw 1;                                                          % bulb
call `a entry(u,5);                                                 % opening hook
hpen;  draw |w1|5..|w1#|4{0,-1}..|w0#|3{-1,0}..2{0,1}.              % stem and tail
```

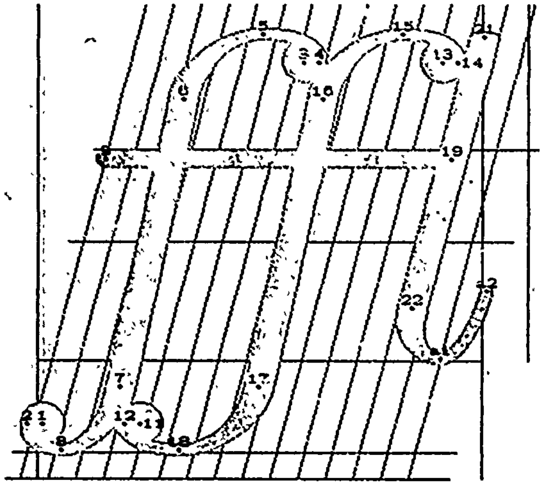
The file italig.mf

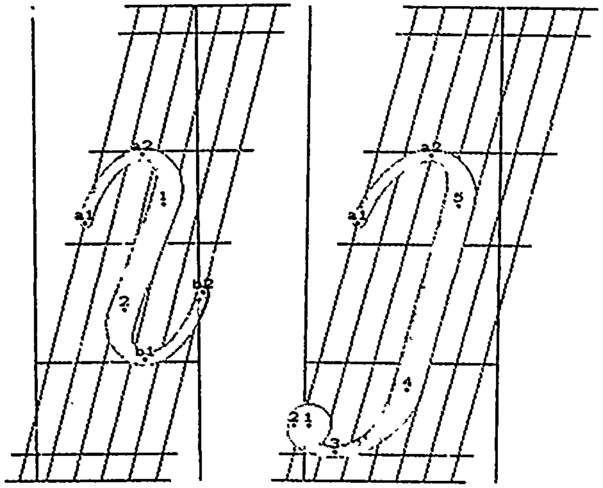
```
"Italic ligature ff";
call charbegin('173,10,0,0,ph,pd,ph·slant + .75pu);
cpen;  lft3x1 = lft0x2 = round(-.25u);  rt3x3 = rt0x4 = round(.5r + 1.75u);
x5 = .5[x6,x4];  x6 = good1(.25r - .5u);  x7 = good1(.25r + .5u);  x8 = .5[x2,x7];
bot3y1 = -.9d;  y2 = y1;  y3 = y4;  y5 - y3 = y2 - y8;
top6y5 = h + oo;  y5 - y6 = y7 - y8;  bot6y7 = -1/3d;  bot6y8 = -d - oo;
lft3x11 = lft0x12 = round(.5r - 1.75u);  rt3x13 = rt0x14 = round(r + .25u);
x15 = .5[x16,x14];  x16 = good1(.75r - .5u);  x17 = good1(.75r + .5u);  x18 = .5[x12,x17];
y11 = y1;  y12 = y2;  y13 = y3;  y14 = y4;  y15 = y5;  y16 = y6;  y17 = y7;  y18 = y8;
x9 = x6 - 2.25u - eps;  x19 = x16 + 1.75u + eps;  top10y9 = m;  y9 = y19;
w3 draw 1;  draw 3;  draw 11;  draw 13;                             % bulbs
w10 draw 9..19;                                                     % bar
hpen;  draw |w0|4{0,1}..|w0#|5{-1,0}..|w1#|6{x7 - x6,y7 - y6}..
     |w1#|7{x7 - x6,y7 - y6}..|w0#|8{-1,0}..2{0,1};                 % left stem
draw |w0|14{0,1}..|w0#|15{-1,0}..|w1#|16{x17 - x16,y17 - y16}
     |w1#|17{x17 - x16,y17 - y16}..|w0#|18{-1,0}..12{0,1}           % right stem
lig `f:  `i = '174, `f = '173, `l = '175;

"Italic ligature fi";
call max(rhook, ph·slant + .5pwi - 2pu);
call charbegin('174,10,0,0,ph,pd,acc);
cpen;  lft3x1 = lft0x2 = round(-.25u);  rt3x3 = rt0x4 = rt1x11;
x5 = .5[x6,x4];  x6 = good1(.25r - .5u);  x7 = good1(.25r + .5u),  x8 = .5[x2,x7],
bot3y1 = -.9d;  y2 = y1;  y3 = y1;  y5 - y3 = y2 - y8;
top6y5 = h + oo;  y5 - y6 = y7 - y8;  bot6y7 = -1/3d;  bot6y8 = -d - oo;
x11 = x12 = good1 .75r,  top6y11 = m,
x9 = x6 - 2.25u - eps;  top10y9 = m,  x19 = x11;  y19 = y9;
w3 draw 1;  draw 3;                                                 % bulbs
w10 draw 9..19;                                                     % bar
hpen;  draw |w0|4{0,1}..|w0#|5{-1,0}..|w1#|6{x7 - x6,y7 - y6}..
     |w1#|7{x7 - x6,y7 - y6}..|w0#|8{-1,0}..2{0,1};                 % left stem
call `a exit(12,r);                                                 % closing hook
w1 draw 11..12.                                                     % right stem
```





```
"Italic ligature fl";
call max(rhook, ph·slant + .5pwi − 2pu);
call charbegin('175, 10, 0, 0, ph, pd, acc);
cpen;  lft_3x_1 = lft_0x_2 = round(−.25u);   rt_3x_3 = rt_0x_4 = round(.5r + 2u);
x_5 = .5[x_6, x_4];   x_6 = good_1(.25r − .5u);   x_7 = good_1(.25r + .5u),   x_8 = .5[x_2, x_7];
bot_3y_1 = −.9d;   y_2 = y_1;   y_3 = y_4;   y_5 − y_4 = y_2 − y_8;
top_6y_5 = h + oo;   y_5 − y_6 = y_7 − y_8;   bot_6y_7 = −⅓d;   bot_6y_8 = −d − oo;
x_11 = x_12 = good_1 .75r;   top_6y_11 = h;
x_9 = x_6 − 2.25u − eps;   top_10y_9 = m;   x_19 = x_11;   y_19 = y_9;
w_3 draw 1;  draw 3;                                                              % bulbs
w_10 draw 9..19;                                                                  % bar
hpen;  draw |w_0|4{0,1}..|w_0#|5{−1,0}..|w_1#|6{x_7 − x_6, y_7 − y_6}..             % left stem
     |w_1#|7{x_7 − x_6, y_7 − y_6}..|w_0#|8{−1,0}..2{0,1},                        % closing hook
call `a exit(12, r);                                                              % right stem
w_1 draw 11..12.

"Italic ligature ffl";
call max(rhook, ph·slant + .5pwi − 2pu);
call charbegin('176, 15, 0, 0, ph, pd, acc);
cpen;  lft_1x_1 = lft_0x_2 = round(−.25u);   rt_3x_3 = rt_0x_4 = round(⅓r + 1.75u);
x_5 = .5[x_6, x_4];   x_6 = good_1 2u;   x_7 = good_1 3u,   x_8 = 5[x_2, x_7];
bot_3y_1 = −.9d;   y_2 = y_1;   y_3 = y_4,   y_5 − y_3 = y_2 − y_8;
top_6y_5 = h + oo;   y_5 − y_6 = y_7 − y_8;   bot_6y_7 = −⅓d;   bot_6y_8 = −d − oo,
lft_3x_11 = lft_0x_12 = round(⅓r − 1.75u);   rt_3x_13 = rt_0x_14 = rt_1x_21;
x_15 = .5[x_16, x_14];   x_16 = good_1 7u;   x_17 = good_1 8u;   x_18 = .5[x_12, x_17];
y_11 = y_1;   y_12 = y_2;   y_13 = y_3;   y_14 = y_4;   y_15 = y_5;   y_16 = y_6;   y_17 = y_7;   y_18 = y_8;
x_21 = x_22 = good_1(r − 2.5u);   top_6y_21 = m;
x_9 = x_6 − 2.25u − eps;   x_19 = x_21;   top_10y_9 = m;   y_9 = y_19;                % bulbs
w_3 draw 1;  draw 3;  draw 11;  draw 13;                                          % bar
w_10 draw 9..19;
hpen;  draw |w_0|4{0,1}..|w_0#|5{−1,0}..|w_1#|6{x_7 − x_6, y_7 − y_6}.            % left stem
     |w_1#|7{x_7 − x_6, y_7 − y_6}..|w_0#|8{−1,0}..2{0,1};
draw |w_0|14{0,1}..|w_0#|15{−1,0}..|w_1#|16{x_17 − x_16, y_17 − y_16}.             % right stem
     |w_1#|17{x_17 − x_16, y_17 − y_16}..|w_0#|18{−1,0}..12{0,1};                  % closing hook
call `a exit(22, r);                                                              % right stem
w_1 draw 21..22.

lig '173:   `i = '176, `l = '177;
```

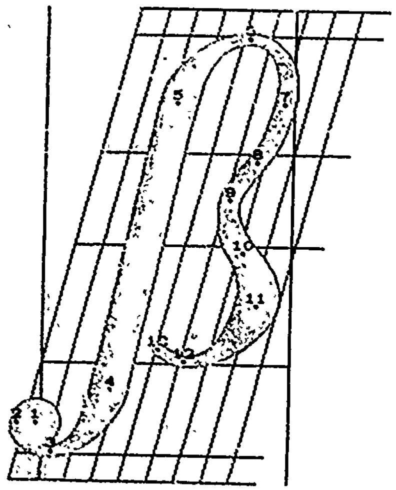


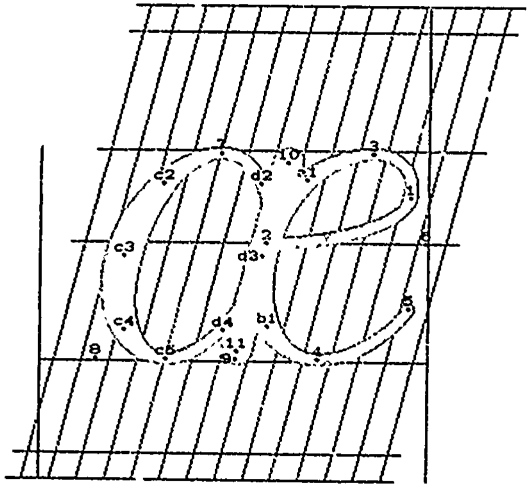


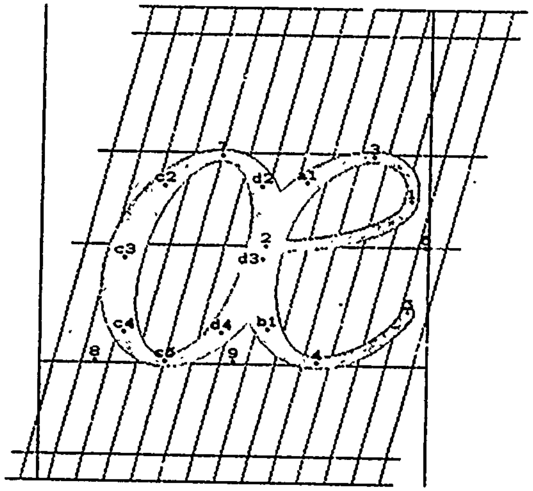
```
'Italic ligature ffl",
call max(rhook, ph.slant + .5pwi − 2pu);
call charbegin('177, 15, 0, 0, ph, pd, acc);
cpen;   lft3x1 = lft0x2 = round(−.5u),   rt3x3 = rt0x4 = round(1/3r + 2u),
x5 = .5[x6, x4];   x6 = good1 2.25u;   x7 = good1 2.75u;   x8 = .5[x2, x7];
bot3y1 = −.9d,   y2 = y1;   y3 = y4;   y5 − y4 = y2 − y8;
top6y5 = h + oo;   y5 − y6 = y7 − y8;   bot6y7 = −1/3d;   bot6y8 = −d − oo;
lft3x11 = lft0x12 = round(1/3r − 2u);   rt3x13 = rt0x14 = round(2/3r + 2u);
x15 = .5[x16, x14];   x16 = good1 7.25u;   x17 = good1 7.75u;   x18 = .5[x12, x17];
y11 = y1;   y12 = y2;   y13 = y3;   y14 = y4;   y15 = y5;   y16 = y6;   y17 = y7;   y18 = y8;
x21 = x22 = good1(r − 2.5u);   top6y21 = h;
x9 = x6 − 2.25u − eps;   x19 = x21;   top10y9 = m,   y9 = y19,
w3 draw 1;   draw 3;   draw 11;   draw 13;                                      % bulbs
w10 draw 9..19;                                                                  % bar
hpen;   draw |w0|4{0, 1}..|w0#|5{−1, 0}..|w1#|6{x7 − x6, y7 − y6}..
     |w1#|7{x7 − x6, y7 − y6}..|w0#|8{−1, 0}..2{0, 1};                         % left stem
draw |w0|14{0, 1}..|w0#|15{−1, 0}..|w1#|16{x17 − x16, y17 − y16}..
     |w1#|17{x17 − x16, y17 − y16}..|w0#|18{−1, 0}..12{0, 1};                  % right stem
call `a exit(22, r);                                                            % closing hook
w1 draw 21..22.                                                                  % right stem
```

The file itals.mf

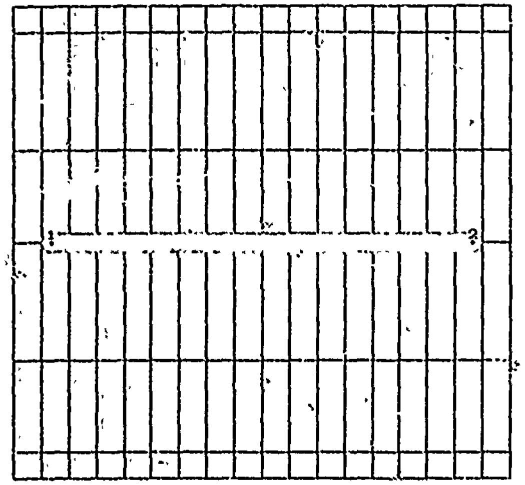
```
% This file contains special letters and letter combinations,
% compatible with the alphabet "itall".
% Codes '013, '014, '033 '035 are used.

"Dotless italic letter i";
call charbegin('013, 7, 1 − fixwidth, 1 − fixwidth, px, 0, 0),
x1 = .5r + .25u;   x2 = .5r − .25u;
call `a skewentry(u, 1);                                                        % opening hook
call `b skewexit(2, r − u);                                                     % closing hook
hpen;   w1 draw 1..2.                                                            % stem

"Dotless italic letter j",
call charbegin('014, 8, 1 − fixwidth, 1 − fixwidth, px, pd, 0);
cpen;   lft3x1 = lft0x2 = round .5u;   x3 = 2.5u;   x4 = x5 = good1 .5(r + u),
bot3y1 = −.9d,   y2 = y1,   bot6y3 = −d − oo,   bot6y4 = −1/3d;
w1 draw 1;                                                                       % bulb
call `a entry(u, 5);                                                            % opening hook
hpen;   draw |w1|5..|w1#|4{0, −1}..|w0#|3{−1, 0}..2{0, 1}.                      % stem and tail
```

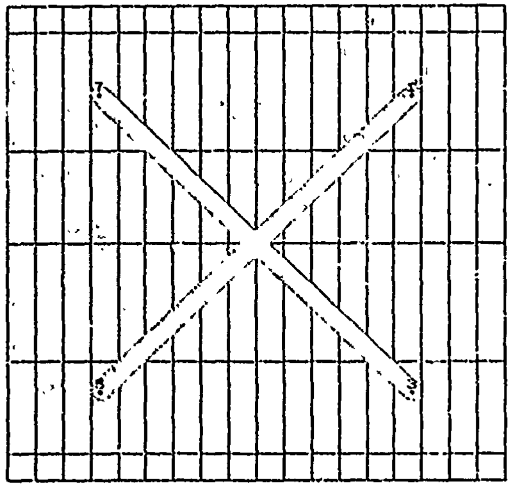


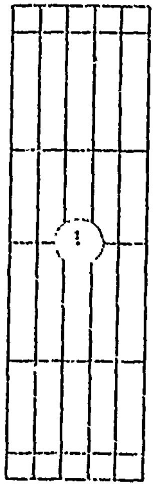




```
"Italic German letter ss";
call charbegin('033, 9, 0, 0, ph, pd, 0);
cpen;  lft1x1 = lft0x2 = round(−.5u),   x3 = .5[x2, x1];
x4 = good1 2.75u;   x5 = good1 2.25u;
x6 = .5[x5, x7];   rt10x7 = round(r − 2.5u);   x8 = .6[x6, x7];   rt10x9 = round(r − 3.5u);
x10 = .5[x9, x11];   rt2x11 = round(r − u);   x12 = x10 − u;   lft0x13 = rt1x1 + 5u,
bot3y1 = −.9d;   y1 = y2;   bot6y3 = −d − oo;   bot6y4 = −⅓d;   y6 − y5 = y4 − y3;
top6y6 = h + oo;   y5 = y7;   y8 = .6[y7, y9];   y9 = .5[e, m];   y10 = .5[y9, y11],
y11 = .5e;   bot6y12 = −oo;   y13 = .125e;
w1 draw 1;                                                                  % bulb
hpen;   draw |w0|2{0, −1}..|w0#|3{1, 0}..|w1#|4{x5 − x1, y5 − y1}..
     |w1#|5{x5 − x1, y5 − y1}..|w0#|6{1, 0}..|w2#|7{0, −1}..8{1.5(x9 − x8), y9 − y8}..
     |w10#|9{0, −1}..|.5[w10, w2]|10{2(x10 − x9), y10 − y9}..|w2#|11{0, −1}..
     |w0#|12{−1, 0}..13(..9).                                               % stroke

"Italic ligature ae";
call charbegin('034, 13, 0, 0, px, 0, 0);
hpen;   rt0x1 = round(r − 1.5u);   x2 = good1 .5r;
x3 = x4 = .5(r + 6u);   rt0x5 = r − .5u;   x6 = x5;
y1 = .5[e, m];   y2 = e;   top0y3 = m + oo;   bot0y4 = −oo,   top0y5 = .5e;   y6 = e;
w0 draw 2{1, 0}..1{0, 1}..3{−1, 0}..3{−1, 0};                    % bar and shoulder
call `a arc(3, 2, w1);   call `b arc(4, 2, w1);                            % right bowl
draw 4{1, 0}..5(..6);                                                       % point
x7 = .5[x8, x9];   x8 = good2 1.5u;   x9 = x2;   y7 = y1;   y8 = y9 = y1;
call `c darc(7, 8, w2);   call `d darc(7, 9, w0);                            % left bowl
cpen;   x10 = x11 = x2;   top1y10 = m + oo;   bot1y11 = −oo;
w1 draw 10..11.                                                             % stem

"Italic ligature oe";
call charbegin('035, 13, 0, 0, px, 0, 0);
hpen;   rt0x1 = round(r − 1.5u);   x2 = good2 .5r;
x3 = x4 = .5(r + 6u);   rt0x5 = r − .5u;   x6 = x5;
y1 = .5[e, m];   y2 = e;   top0y3 = m + oo,   bot0y4 = −oo,   top0y5 = .5e,   y6 = e;
w0 draw 2{1, 0}..1{0, 1}..3{−1, 0}..3{−1, 0};                    % bar and shoulder
call `a arc(3, 2, w2);   call `b arc(4, 2, w2);                            % right bowl
draw 4{1, 0}..5(..6);                                                       % point
x7 = .5[x8, x9];   x8 = good2 1.5u;   x9 = x2,   y7 = y1;   y8 = y9 = y1,
call `c darc(7, 8, w2);   call `d darc(7, 9, w2).                            % left bowl
```



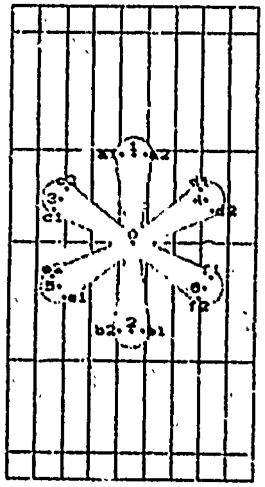


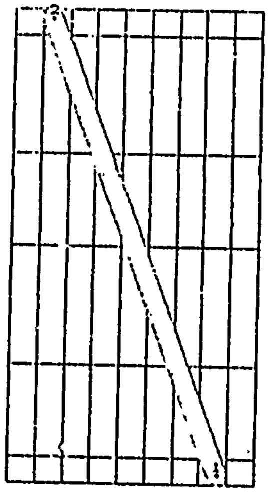


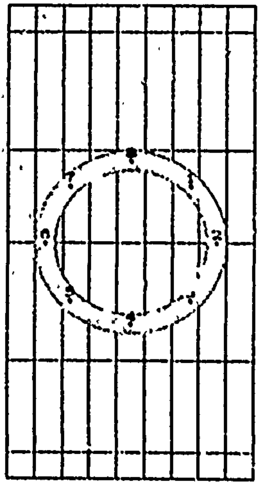
SYMBOL CHARACTER DESIGNS

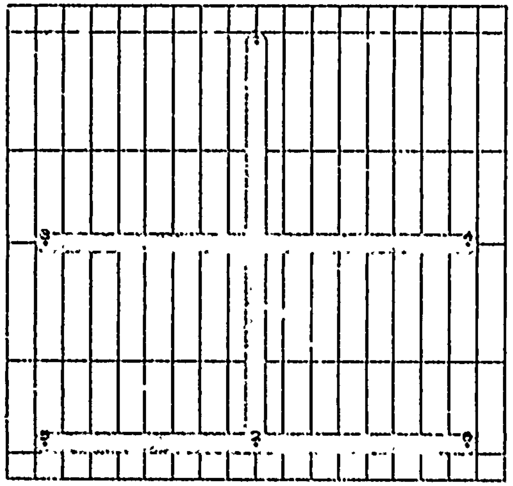
The file symbol.mf

```
% The Computer Modern Symbols family of fonts (by D  E. Knuth, 1979).
danger = 0;
mi = 1;   input script;                                % upper case script alphabet
texinfo slant, 6pu, 3pu, 2pu, px, 18pu;
% (The calling file should give the rest of the texinfo.)
new slant;   slant = 0;   trxy 0;              % the non-script characters are unslanted

"Minus sign";
cpen;
if fixwidth = 0:   if pa + 8pu > ph:
            call charbegin('000, 18, 0, 0, ph, ph - 2pa, 0);
      else:   call charbegin('000, 18, 0, 0, 8pu + pa, 8pu - pa, 0);
      fi;
else:   call charbegin('000, 9, 0, 0, 3.5pu + pa, 3.5pu - pa, 0),
fi;
lft10x1 = round u;   x2 = r - x1;   y1 = y2 = a;
w10 draw 1..2.                                                             % bar

"Period raised to axis height";
call charbegin('001, 5, 0, 0, pa + .75pwiii, 0, 0);
cpen;   new w99;
if w3 < w0 sqrt 2:   w99 = round w0 sqrt 2;
else:   w99 = w3;
fi;
x1 = good99.5r;   y1 = a;   w99 draw 1.                                    % dot

"Times operator";
call charbegin('002, 18, 0, 0, 1/sqrttwo[pa, ph], 1/sqrttwo[pa, ph - 2pa], 0);
cpen;   x7 = 1/sqrttwo[.5r, u];   y7 = 1/sqrttwo[a, h];
x5 = x7;   x1 = x3 = r - x7;   y1 = y7;   y3 = y5;   .5[y1, y3] = a,
w10 draw 7..3;                               % upper left to lower right diagonal
draw 5..1.                                   % lower left to upper right diagonal
```

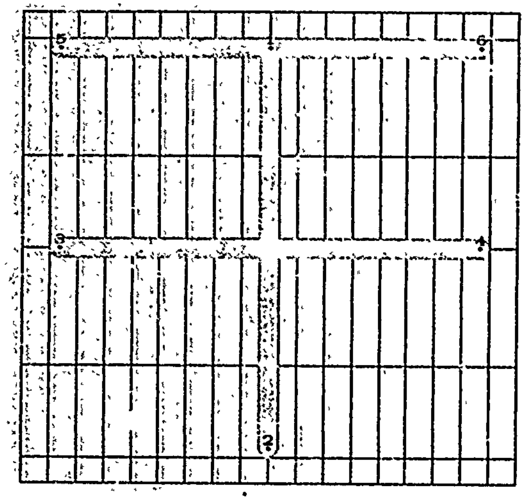


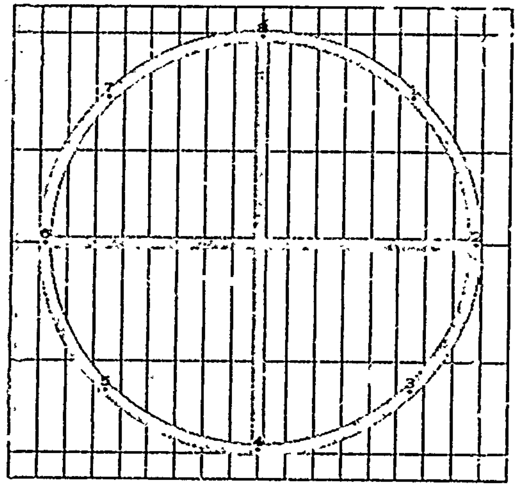


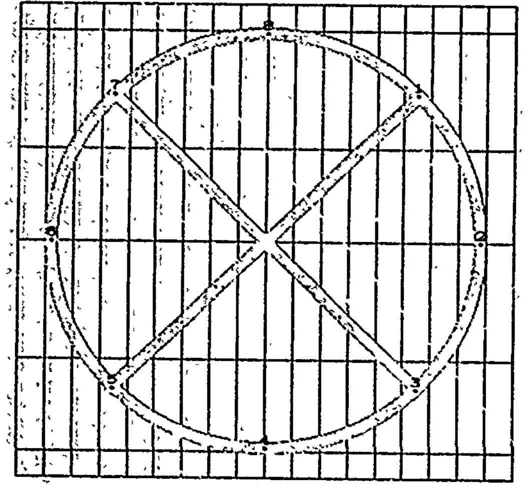


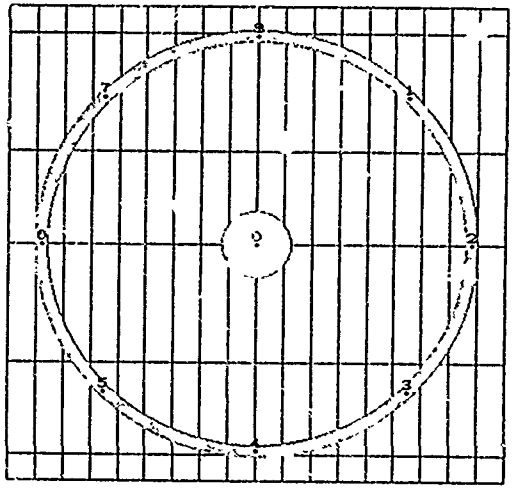


```
 Asterisk at the axis";
call charbegin('003, 9, 0, 0, 5px + pa, 5px -- pa, 0);
cpen;  top1y1 = round(a + 5m);  top1y1 - bot1y2 = m;
y0 = .5[y1, y2];  x0 = r - x0;  x1 = x2 = x0;  x3 = r -- x1;  x5 = r - x0;  x1 --
x5;                                                       % left-right symmetry
y3 = y1;  y5 = y0;  y1 -- y5 = y1 - y0;  .5[y1, y5] = y0;
x1 - x0 = (.5 sqrt 3)lft1 3.75u;          % asterisk will have 60-degree angles if m = 7.5u
call `a cdraw(1, 0, 1, 0);                                          % upper arm
call `b cdraw(2, 0, 1, 0);                                          % lower arm
call `c cdraw(3, 0, 1, 0);                                     % upper left arm
call `d cdraw(4, 0, 1, 0);                                    % upper right arm
call `e cdraw(5, 0, 1, 0);                                     % lower left arm
call `f cdraw(6, 0, 1, 0).                                    % lower right arm

"Reverse slash";
call charbegin('004, 9, 0, 0, ph + pb, ph + pb - 2pa, 0);
cpen;  lft10x2 = round u;  x2 = r -- x1;
top10y2 = h + b;  .5[y1, y2] = a;
w10 draw 1 . . 2.                                                  % diagonal

"Circle operator";
call charbegin('005, 9, 0, 0, 3.5pu + pa, 3 5pu -- pa, 0);
cpen;  x8 = 5r;  lft10x-- = round u  top10y8 = round(a + 3 5u);  y6 = a;
call circle(1, 2, 3, 4, 5, 6. 7, 8, w10).                              % bowl

"Plus or minus sign' ;
cpen;
if fixwidth = 0:  if pa + 8pu > ph:
          call charbegi.('006, 18, 0, 0, ph, ph - 2pa, 0),  top10y1 = h,
     else:  call charbegin('006, 18, 0, 0, 8pu + pa, 8pu -- pa, 0),  top10y1 = a + 8u;
     fi;
else  call charbegin('006, 9, 0, 0, 3 5pu + pa, 3.5pu - pa, 0),  top10y1 = a + 3 5u,
fi;
.5[y1, y2] = a;  x1 = x2 = 5r;
lft10x1 = round u;  x1 = r - x1;  y3 = y1 = a;
w10 draw 1 . . 2;                                                      % stem
draw 3 . . 4;                                                      % plus bar
x5 = x1;  x6 = x1;  y5 = y6 = y2,  draw 5 . 6.                    % minus bar
```

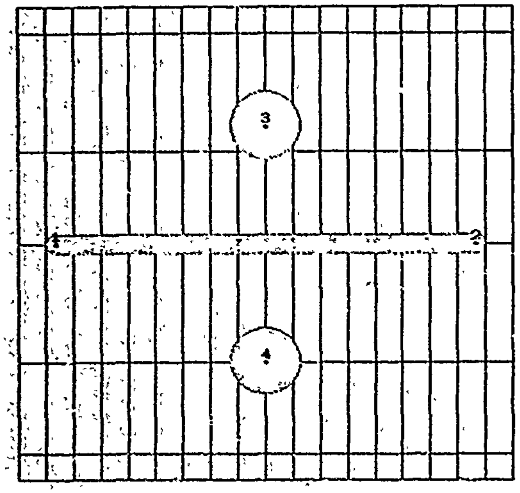


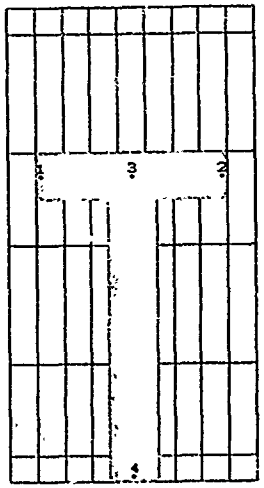


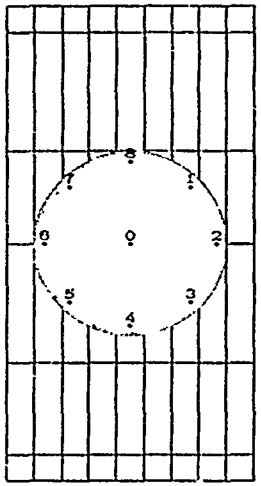


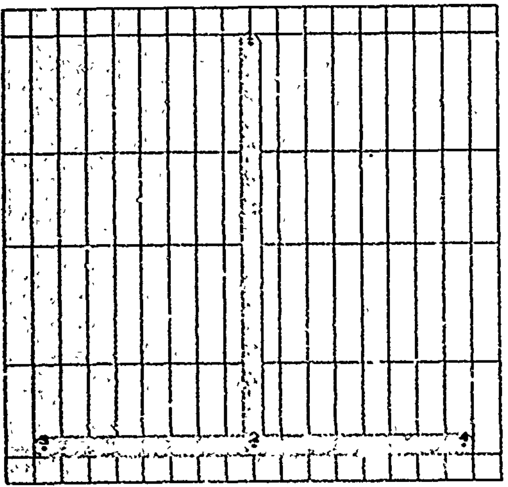


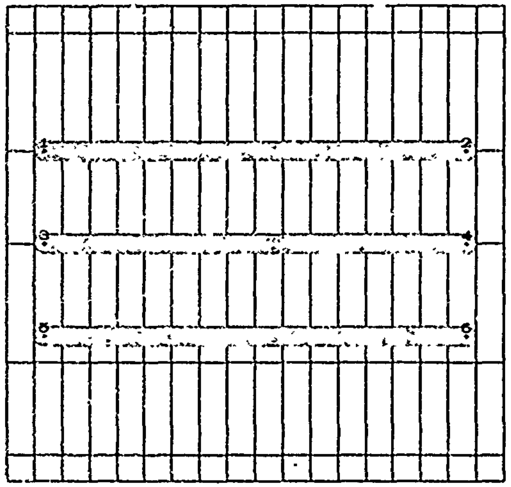
```
"Minus or plus sign";
cpen;
if fixwidth = 0:  if pa + 8pu > ph:
        call charbegin('007, 18, 0, 0, ph, ph − 2pa, 0);   top10y1 = h;
    else:  call charbegin('007, 18, 0, 0, 8pu + pa, 8pu − pa, 0);   top10y1 = a + 8u;
    fi;
else:  call charbegin('007, 9, 0, 0, 3.5pu + pa, 3.5pu − pa, 0);   top10y1 = a + 3.5u,
fi;
.5[y1, y2] = a;   x1 = x2 = .5r,
lft10x3 = round u;   x4 = r − x3;   y3 = y4 = a;
w10 draw 1..2;                                                  % stem
draw 3..4;                                                      % plus bar
x5 = x3;   x6 = x4;   y5 = y6 = y1;   draw 5..6.                % minus bar

"Circle-plus operator";
call charbegin('010, 18, 0, 0, ph, ph − 2pa, pa·slant − 5pu);
cpen;   lft0x6 = round u;   y6 = a,   x2 = r − x6;   top0y8 = h + oo,
call circle(1, 2, 3, 4, 5, 6, 7, 8, w0);                        % bowl
w0 draw 6..2;                                                   % bar
draw 4..8.                                                      % stem

"Circle-minus operator";
call charbegin('011, 18, 0, 0, ph, ph − 2pa, pa·slant − 5pu);
cpen;   lft0x6 = round u;   y6 = a;   x2 = r − x6;   top0y8 = h + oo;
call circle(1, 2, 3, 4, 5, 6, 7, 8, w0);                        % bowl
w0 draw 6..2.                                                   % bar

"Circle-times operator";
call charbegin('012, 18, 0, 0, ph, ph − 2pa, pa·slant − 5pu);
cpen;   lft0x6 = round u;   y6 = a,   x2 = r − x6;   top0y8 = h + oo;
call circle(1, 2, 3, 4, 5, 6, 7, 8, w0);                        % bowl
w0 draw 7..3;                        % upper left to lower right diagonal
draw 5..1.                           % lower left to upper right diagonal

"Circle-divide operator";
call charbegin('013, 18, 0, 0, ph, ph − 2pa, pa·slant − 5pu);
cpen;   lft0x6 = round u;   y6 = a;   x2 = r − x6,   top0y8 = h + oo,
call circle(1, 2, 3, 4, 5, 6, 7, 8, w0);                        % bowl
w0 draw 5..1.                        % lower left to upper right diagonal

"Circle dot operator";
call charbegin('014, 18, 0, 0, ph, ph − 2pa, pa·slant − 5pu),
cpen;   lft0x6 = round u;   y6 = a;   x2 = r − x6,   top0y8 = h + oo;
call circle(1, 2, 3, 4, 5, 6, 7, 8, w0);                        % bowl
x0 = x8;   y0 = y2;
cpen;   new w99;   w99 = w3 sqrt 2;   w99 draw 0.               % dot
```



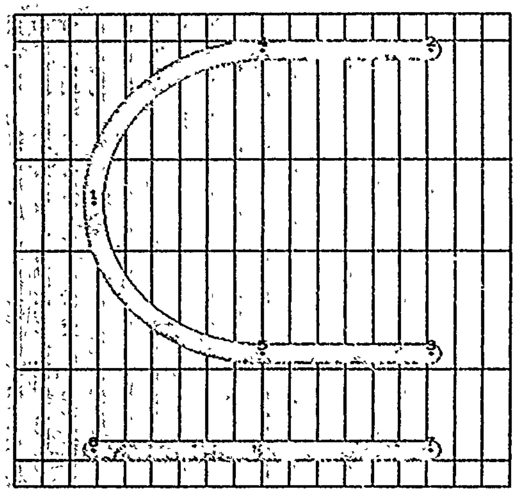


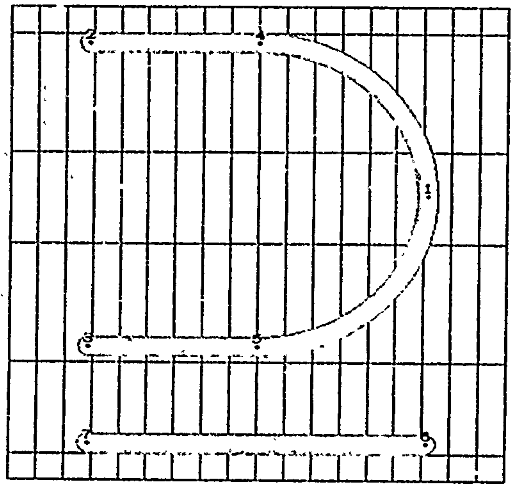


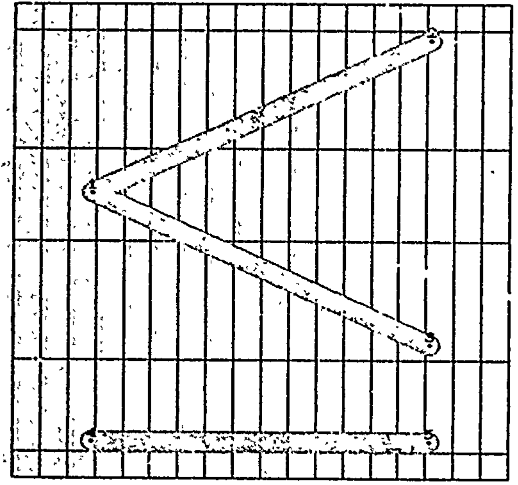


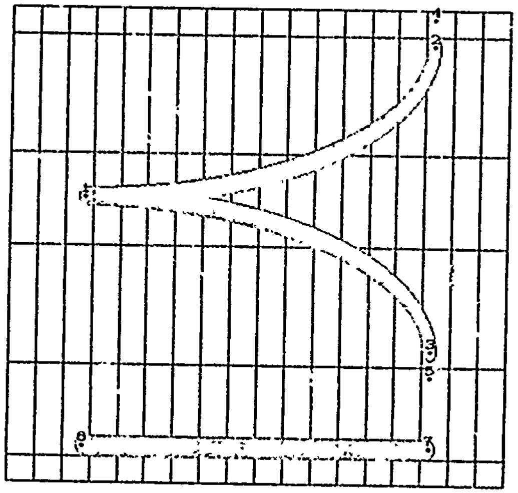


```
"Elementary division operator";
call charbegin('015, 18, 0, 0, .5[px, ph], .5[px, ph] − 2pa, 0);
cpen;  lft_10 x_1 = round u;  x_2 = r − x_1,  y_1 = y_2 = a;
w_10 draw 1..2;                                                  % bar
new w_99,  w_99 = w_1 sqrt 2;
top_99 y_3 = .5[m, h];  .5[y_3, y_4] = a;
x_3 = x_4 = .5r;
w_99 draw 3;  draw 4.                                            % dots

"Intercalation product operator";
call charbegin('016, 9, 0, 0, px, pd + pb, 0);
vpen;  lft_3 x_1 = u;  rt_3 x_2 = r − u;  x_3 = x_4 = .5r;
top_3 y_1 = m;  y_1 = y_2 = y_3;  bot_0 y_4 = −d − b;
w_3 draw 1..2;                                                   % bar
hpen;  w_3 draw 3..4.                                            % stem

"Bullet";
call charbegin('017, 9, 0, 0, 3.5pu + pa, 3.5pu − pa, 0);
cpen;  x_8 = .5r;  lft_10 x_6 = round u;  top_10 y_8 = round(a + 3.5u);  y_6 = a;
call circle(1, 2, 3, 4, 5, 6, 7, 8, w_10);                       % outer boundary
x_0 = x_8;  y_0 = y_2;
cpen;  w_10 ddraw 1{x_2 − x_8, y_2 − y_8}..2{0, −1}..3{x_4 − x_2, y_4 − y_2}..4{−1, 0}..
    5{x_6 − x_4, y_6 − y_4}..6{0, 1}..7{x_8 − x_6, y_8 − y_6}..8{1, 0}..1{x_2 − x_8, y_2 − y_8},
    0..0..0..0..0..0..0..0..0.                                   % fill it in

"Perpendicular sign or lattice bottom";
cpen;
if fixwidth = 0:  if pa + 8pu > ph:
        call charbegin('020, 18, 0, 0, ph, ph − 2pa, 0);  top_10 y_1 = h;
    else:  call charbegin('020, 18, 0, 0, 8pu + pa, 8pu − pa, 0);  top_10 y_1 = a + 8u;
    fi;
else:  call charbegin('020, 9, 0, 0, 3.5pu + pa, 3.5pu − pa, 0);  top_10 y_1 = a + 3.5u;
fi;
.5[y_1, y_2] = a;  x_1 = x_2 = .5r;
lft_10 x_3 = round u;  x_4 = r − x_3;  y_3 = y_4 = y_2;
w_10 draw 1..2;                                                  % stem
draw 3..4.                                                       % bar

"Equivalence or congruence sign";
call charbegin('021, 18, 0, 0, px − pe + prt/2 + pa, px − pe + prt/2 − pa, 0);
cpen;  lft_10 x_1 = round u;  x_3 = x_5 = x_1;  x_2 = x_4 = x_6 = r − x_1;
y_1 = y_2;  y_3 = y_4 = a;  y_5 = y_6;  y_1 − y_3 = y_3 − y_5 = round(m − e);
w_10 draw 1..2;                                                  % upper bar
draw 3..4;                                                       % middle bar
draw 5..6.                                                       % lower bar
```

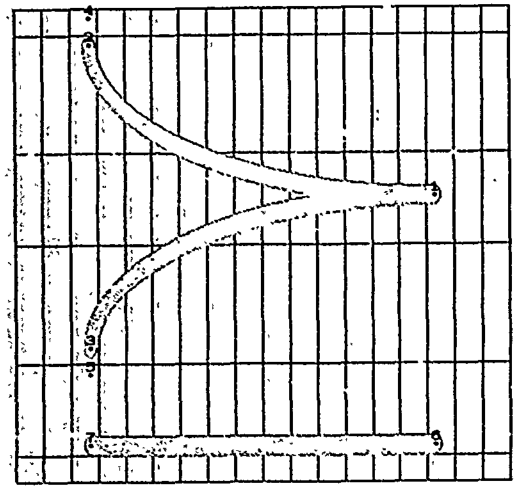


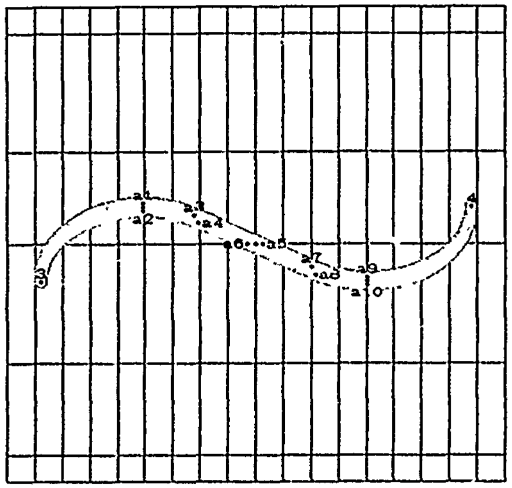


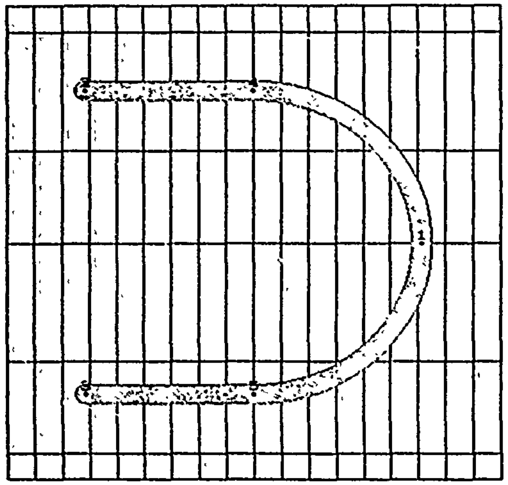


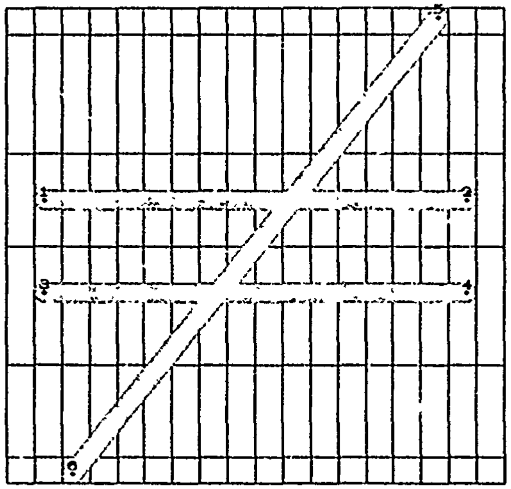


```
'Reflexive subset sign";
call charbegin('022, 18, 0, 0, ph, ph − 2pa, 0);
cpen;   lft_{10}x_1 = round 2 5u;   x_2 =· x_1 = r − x_1;
top_{10}y_2 = h;   .5[y_2, y_3] = y_1;   y_2 − y_1 = (good_{10} 5[m, h]) − (good_{10}a);
x_1 = x_5 = .5r;   y_1 = y_2;   y_5 = y_3,
w_{10} draw 2..4{−1,0}. 1{0,−1} .5{1,0}. 3;                          % stroke
x_6 = x_1;   x_7 = x_2;   y_6 = y_7;   bot_{10}y_6 = 2a − h;
draw 6 .7.                                                           % bar

"Reflexive superset sign";
call charbegin('023, 18, 0, 0, ph, ph − 2pa, 0);
cpen;   lft_{10}x_2 = round 2.5u;   x_2 = x_3 = r − x_1,
top_{10}y_2 = h;   5[y_2, y_3] = y_1;   y_2 − y_1 = (good_{10} 5[m, h]) − (good_{10}a),
x_1 = x_5 = .5r;   y_1 = y_2;   y_5 = y_3;
w_{10} draw 2..4{1,0} .1{0, −1}. 5{−1,0} .3;                         % stroke
x_6 = x_1;   x_7 = x_2,   y_6 = y_7,   bot_{10}y_6 = 2a − h;
draw 6..7.                                                           % bar

"Less than or equal to sign";
call charbegin('024, 18, 0, 0, ph, ph − 2pa, 0);
cpen;   lft_{10}x_1 = round 2.5u;   x_2 = x_3 = r − x_1,
top_{10}y_2 = h;   .5[y_2, y_3] = y_1;   y_2 − y_1 = (good_{10} .5[m, h]) − (good_{10}a);
w_{10} draw 2..1..1  3;                                              % diagonals
x_1 = x_1;   x_5 = x_2;   y_1 = y_5;   bot_{10}y_1 = 2a − h;
draw 4..5.                                                           % bar

"Greater than or equal to sige";
call charbegin('025, 18, 0, 0, ph, ph − 2pa, 0);
cpen;   lft_{10}x_2 = round 2 5u;   x_2 = x_3 = r − x_1,
top_{10}y_2 = h;   .5[y_2, y_3] = y_1;   y_2 − y_1 = (good_{10} 5[m, h])  − (good_{10}a);
w_{10} draw 2..1..1..3;                                              % diagonals
x_1 = x_1;   x_5 = x_2;   y_1 = y_5,   bot_{10}y_1 = 2a − h;
draw 4..5.                                                           % bar

"Precedes or equals sign";
call charbegin('026, 18, 0, 0, ph, ph −  2pa, 0);
vpen;   lft_{10}x_1 = round 2 5u,   x_2 = x_3 = r − x_1,
top_{10}y_2 = h;   .5[y_2, y_4] = y_1,   y_2 − y_1 = (good_{10} 5[m, h])   (good_{10}a),
x_1 = x_5 − x_2;   y_1 = y_2 + b,   y_5 = y_3 − b;
w_{10} draw (4  )2   1{−1,0}   1{1,0}   3(   5),                      % diagonals
x_6 = x_1,   x_7 = x_2;   y_6 = y_7,   bot_{10}y_6 = 2a − h,
draw 6. 7.                                                           % bar
```

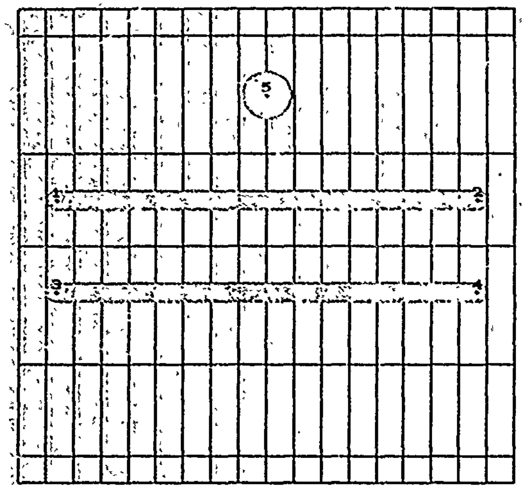


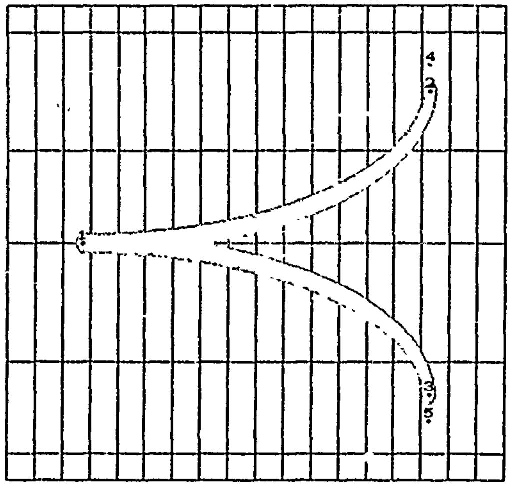


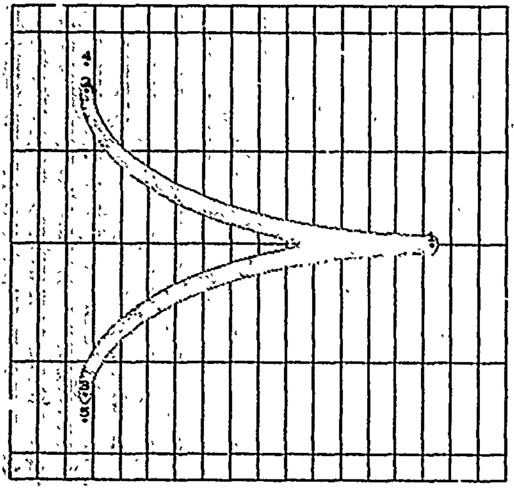


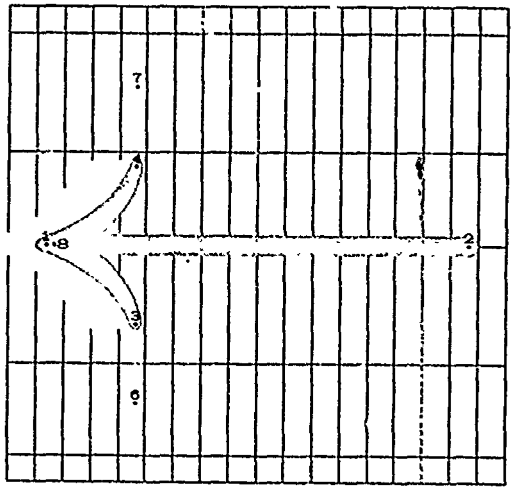


```
"Follows or equals sign";
call charbegin('027, 18, 0, 0, ph, ph − 2pa, 0);
vpen;   lft_10 x_2 = round 2 5u;   x_2 = x_3 = r − x_1;
top_10 y_2 = h;   .5[y_2, y_3] = y_1;   y_2 − y_1 = (good_10 .5[m, h]) − (good_10 a);
x_1 = x_5 = x_2;   y_4 = y_2 + b;   y_5 = y_3 − b;
w_10 draw (4..)2..1{1, 0}..1{−1, 0}..3(..5);                          % diagonals
x_6 = x_1;   x_7 = x_2;   y_6 = y_7;   bot_10 y_6 = 2a − h;
draw 6..7.                                                            % bar

"Similarity sign";
call charbegin('030, 18, 0, 0, .5(px − pe) + pa, 0, 0);
vpen;   top_10 y_1 = round(a + .5(m − e) + eps);   top_10 y_1 − bot_10 y_2 = round(m − e);
lft_10 x_3 = round u;   y_5 = .5[y_1, y_2];   y_3 = y_2;   y_4 = y_1;   x_4 = r − x_1;   x_3 = r − x_5;
call `a zdraw(3, 1, 5, 2, 4, w_10, w_10 + deltaw, 7.5u/(e − m)).           % stroke

"Approximate equality sign";
call charbegin('031, 18, 0, 0, 1.1(px − pe) + pa, 1.1(px − pe) − pa, 0);
vpen;   top_10 y_1 = round(a + 1.1(m − e) + eps);   top_10 y_1 − bot_10 y_2 = round(m − e);
lft_10 x_3 = round u;   y_5 = .5[y_1, y_2];   y_3 = y_2;   y_4 = y_1;   x_4 = r − x_1;   x_5 = r − x_3;
x_8 = x_3;   x_9 = x_4;   x_10 = x_5;
y_1 − y_6 = y_2 − y_7 = y_3 − y_8 = y_4 − y_9 = y_5 − y_10 = round 1.2(m − e);
call `a zdraw(3, 1, 5, 2, 4, w_10, w_10 + deltaw, 7.5u/(e − m));          % upper stroke
call `b zdraw(8, 6, 10, 7, 9, w_10, w_10 + deltaw, 7.5u/(e − m)).         % lower stroke

"Proper subset sign";
call charbegin('032, 18, 0, 0, .5[px, ph] + prt/2, .5[px, ph] + prt/2 − 2pa, 0);
cpen;   lft_10 x_1 = round 2.5u;   x_2 = x_3 = r − x_1;
y_2 = good_10 .5[m, h];   .5[y_2, y_3] = y_1 = good_10 a;
x_4 = x_5 = .5r;   y_4 = y_2;   y_5 = y_3;
w_10 draw 2..4{−1, 0}..1{0, −1}..5{1, 0}..3.                          % stroke

"Proper superset sign";
call charbegin('033, 18, 0, 0, .5[px, ph] + prt/2, .5[px, ph] + prt/2 − 2pa, 0);
cpen;   lft_10 x_2 = round 2.5u;   x_2 = x_3 = r − x_1;
y_2 = good_10 .5[m, h];   .5[y_2, y_3] = y_1 = good_10 a;
x_4 = x_5 = .5r;   y_4 = y_2;   y_5 = y_3;
w_10 draw 2..4{1, 0}..1{0, −1}..5{−1, 0}..3.                          % stroke

"Unequal sign";
call charbegin('034, 18, 0, 0, ph + pb, ph + pb − 2pa, 0);
cpen;   lft_10 x_1 = round u;   x_3 = x_1;   x_2 = x_4 = r − x_1;
y_1 = y_2;   y_3 = y_4;   y_1 − y_3 = round(m − e),   .5[y_1, y_3] = a;
w_10 draw 1..2;                                                       % upper bar
draw 3..4;                                                            % lower bar
rt_10 x_5 = round(r − 2u);   lft_10 x_6 = round 2u;
top_10 y_5 = h + b;   bot_10 y_6 = −d − b;
draw 5..6.                                                            % diagonal
```

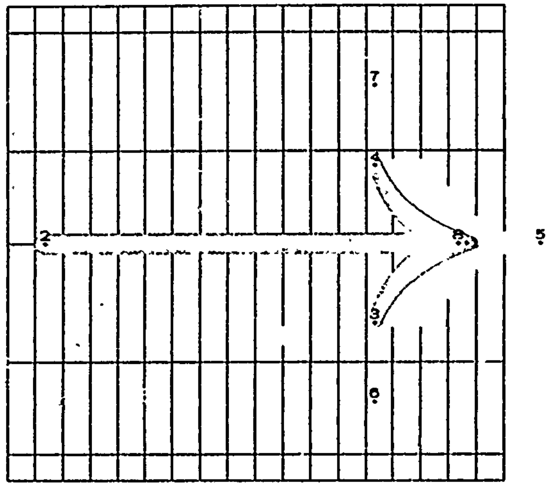


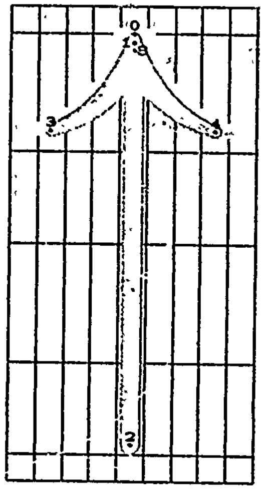


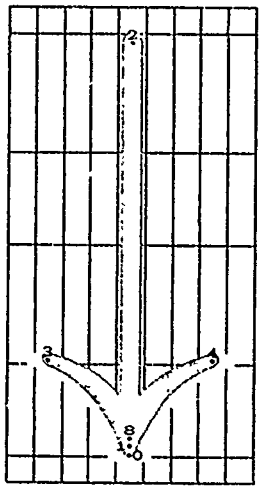




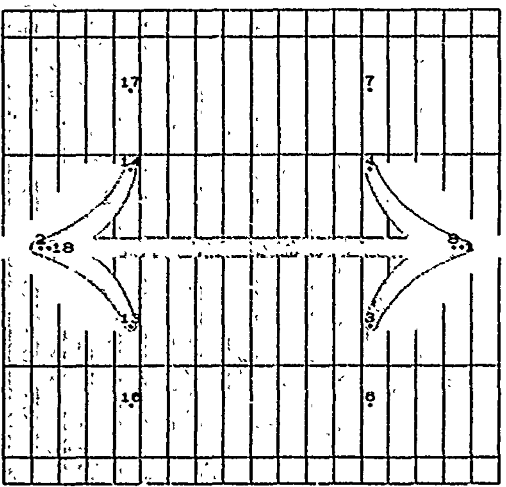
```
"Dot over equal sign";
call charbegin('035, 18, 0, 0, ph, 0, 0);
cpen;   lft10x1 = round u;   x3 = x1;   x2 = x4 = r − x1;
y1 = y2;   y3 = y4;   y1 − y3 = round(m − e),   .5[y1, y3] = a;
w10 draw 1 . 2;                                                  % upper bar
draw 3 . . 4;                                                    % lower bar
new w99;
if w3 < w0 sqrt 2:   w99 = round w0 sqrt 2;
else:   w99 = w3;
fi;
x5 = .5r,   y5 = 5[m, h];   w99 draw 5                           % dot

"Precedes sign";
call charbegin('036, 18, 0, 0, 5[px, ph] + prt/2, 5[px, ph] + prt/2 − 2pa, 0);
vpen;   lft10x1 = round 2 5u;   x2 = x3 = r − x1;
y2 = good10 5[m, h];   .5[y2, y3] = y1 = good10a,
x1 = x5 = x2;   y4 = y2 + b,   y5 = y3 − b;
w10 draw (4 . . )2 . . 1{−1, 0} . 1{1, 0} . . 3(   5).           % diagonals

"Follows sign";
call charbegin('037, 18, 0, 0, .5[px, ph] + prt/2, .5[px, ph] + prt/2 − 2pa, 0),
vpen;   lft10x2 = round 2.5u;   x2 = x3 = r − x1;
y2 = good10.5[m, h];   .5[y2, y3] = y1 = good10a;
x1 = x5 = x2;   y4 = y2 + b;   y5 . − y3 − b;
w10 draw (4 . . )2 . . 1{1, 0} . . 1{−1, 0} . . 3( . . 5).      % diagonals

"Leftward arrow";
call charbegin('040, 18, 0, 0, 24ph + 5prt + pa, 24ph + .5prt − pa, 0);
cpen;   lft10x1 = x0 = round u;   rt10x2 = round(r − u);
y1 = y2 = y5 = y8 = good10a;
w10 draw 1 . . 2;                                                % bar
hpen;   lft1x8 = x0;
x5 − x8 = x8 − x3 = − fixwidth[3u, 6u] − eps;   x4 = x1 = x6 = x7,
y3 − y6 = y1 − y3 = y4 − y1 = y7 − y4 = .24h + eps;
lpen#;   w10 + w1 draw (5 . . )8   3( . . 6);          % erase excess at lower left
hpen;   draw (|w1|5 . . )8 . . |w0|3(   6),                      % lower point
lpen#;   w10 + w1 draw (5 .  )8  . 4( . . 7);          % erase excess at upper left
hpen;   draw (|w1|5 . . )8 . . |w0|4(   7)                       % upper point
```

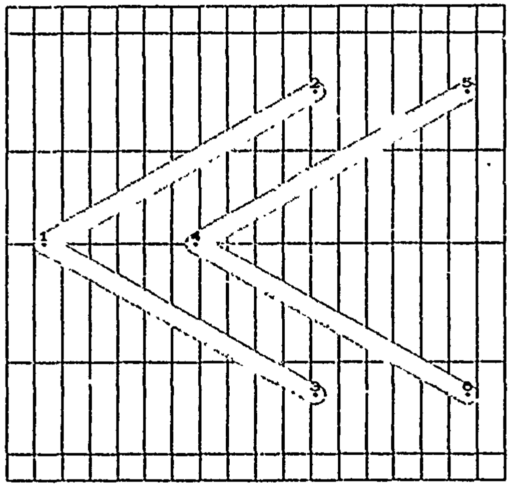


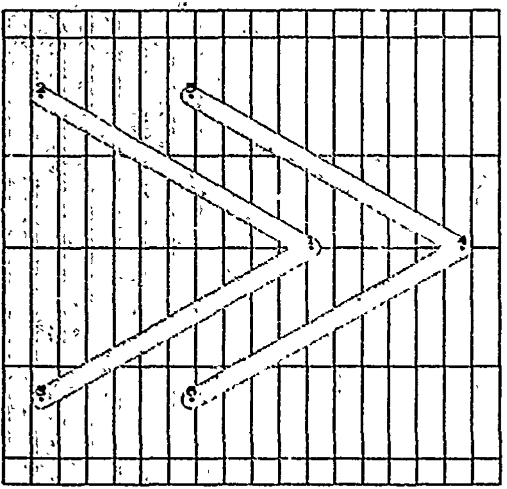


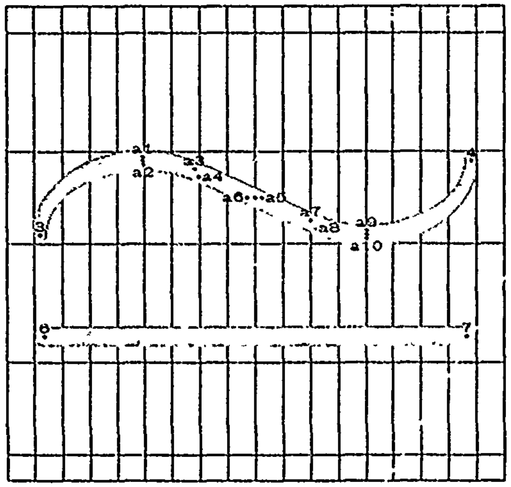


```
"Rightward arrow";
call charbegin('041, 18, 0, 0, .24ph + .5prt + pa, .24ph + 5prt − pa, 0);
cpen;   lft_10 x_2 = round u;   rt_10 x_1 = x_0 = round(r − u);
y_1 = y_2 = y_5 = y_8 = good_10 a;
w_10 draw 1..2;                                                        % bar
hpen,   rt_1 x_8 = x_0;
x_5 − x_8 = x_8 − x_1 = fixwidth[3u, 6u] + eps;   x_3 = x_4 = x_6 = x_7;
y_3 − y_6 = y_1 − y_3 = y_4 − y_1 = y_7 − y_4 = .24h + eps;
rpen#;   w_10 + w_1 draw (5..)8..3(..6);             % erase excess at lower right
hpen;   draw (|w_1|5..)8..|w_0|3(..6);                            % lower point
rpen#;   w_10 + w_1 draw (5..)8..4(..7);             % erase excess at upper right
hpen;   draw (|w_1|5..)8..|w_0|4(..7).                            % upper point

"Upward arrow";
call charbegin('042, 9, 0, 0, ph, ph − 2pa, 0);
cpen;   top_10 y_1 = y_0 = h;   .5[y_1, y_2] = a;
x_0 = x_1 = x_2 = x_5 = x_8 = good_10 .5r;
w_10 draw 1..2;                                                       % stem
vpen;   top_7 y_8 = y_0;
lpen#;   w_10 draw 0..8;   rpen#;   w_10 draw 0..8;               % clean the top
y_5 − y_8 = y_8 − y_3 = .24h + eps;   y_3 = y_4 = y_6 = y_7;
x_3 − x_6 = x_1 − x_3 = x_4 − x_1 = x_7 − x_4 = 3u + eps;
lpen#;   w_10 draw (5..)8..3(..6);                       % erase excess at left
vpen;   draw (|w_7|5..)8..|w_0|3(..6);                              % left point
rpen#;   w_10 draw (5..)8..4(..7);                      % erase excess at right
vpen;   draw (|w_7|5..)8..|w_0|4(..7).                             % right point

"Downward arrow";
call charbegin('043, 9, 0, 0, ph, ph − 2pa, 0);
cpen;   top_10 y_2 = h;   .5[y_1, y_2] = a;   y_0 = bot_10 y_1;
x_0 = x_1 = x_2 = x_5 = x_8 = good_10 .5r;
w_10 draw 1..2;                                                       % stem
vpen;   bot_7 y_8 = y_0;
lpen#;   w_10 draw 0..8;   rpen#;   w_10 draw 0..8;               % clean the top
y_5 − y_8 = y_8 − y_3 = −.24h − eps;   y_3 = y_4 = y_6 = y_7;
x_3 − x_6 = x_1 − x_3 = x_4 − x_1 = x_7 − x_4 = 3u + eps;
lpen#;   w_10 draw (5..)8..3(..6);                       % erase excess at left
vpen;   draw (|w_7|5..)8..|w_0|3(..6);                              % left point
rpen#;   w_10 draw (5..)8..4(..7);                      % erase excess at right
vpen,   draw (|w_7|5..)8..|w_0|4(..7).                             % right point
```

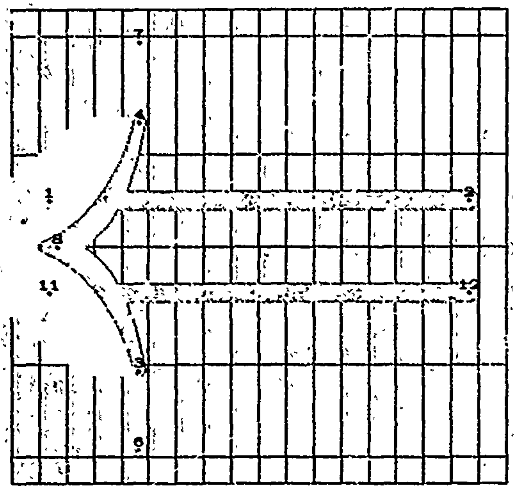


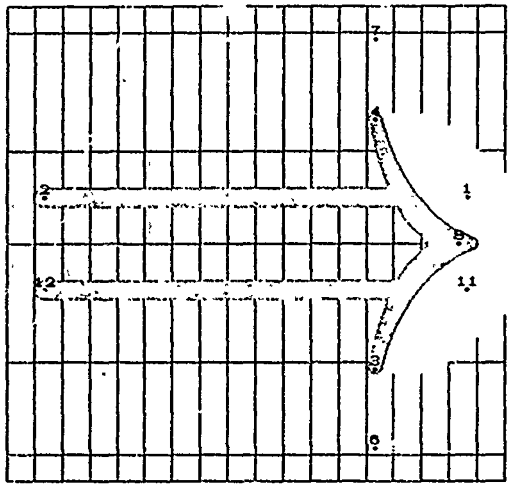


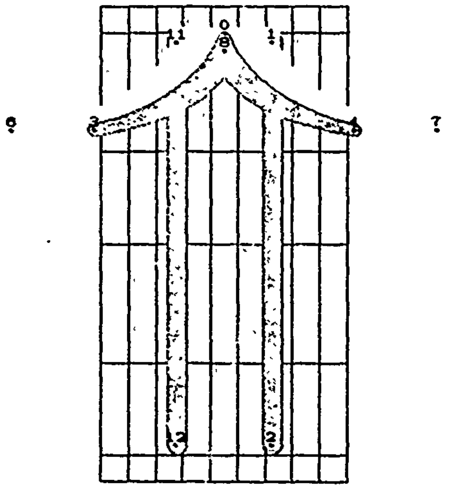




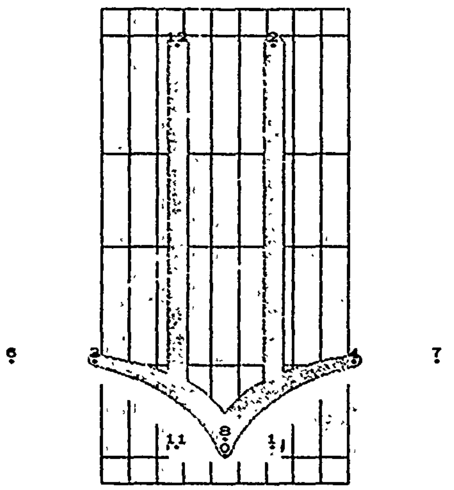
```
"Left-and-right arrow";
call charbegin('044, 18, 0, 0, .24ph + 5prt + pa, 24ph + .5prt - pa, 0);
cpen;   lft_{10}x_2 = x_{10} = round u;   rt_{10}x_1 = x_9 = round(r - u);
y_1 = y_2 = y_5 = y_8 = good_{10}a;
w_{10} draw 1..2;                                                        % bar
hpen;   rt_1x_8 = x_9;   lft_1x_{18} = x_{10};
x_5 - x_8 = x_8 - x_4 = x_{13} - x_{18} = x_{18} - x_{15} = fixwidth[3u, 6u] + eps;
x_3 = x_4 = x_6 = x_7;   x_{13} = x_{14} = x_{16} = x_{17};
y_3 - y_6 = y_4 - y_3 = y_4 - y_4 = y_7 - y_4 = 24h + eps,
y_{13} = y_3;   y_{14} = y_4;   y_{15} = y_5;   y_{16} = y_6;   y_{17} = y_7,   y_{18} = y_8;
rpen#;   w_{10} + w_1 draw (5  .)8..3(. 6);               % erase excess at lower right
hpen;   draw (|w_1|5..)8..|w_0|3(..6);                              % lower right point
rpen#;   w_{10} + w_1 draw (5..)8. 4(..7);                % erase excess at upper right
hpen;   draw (|w_1|5..)8 .|w_0|4( .7);                              % upper right point
lpen#;   w_{10} + w_1 draw (15..)18 .13(..16);              % erase excess at lower left
hpen;   draw (|w_1|15 .)18. |w_0|13(..16);                            % lower left point
lpen#;   w_{10} + w_1 draw (15..)18..14(. 17);              % erase excess at upper left
hpen;   draw (|w_1|15 .)18. |w_0|14(..17).                            % upper left point

"Much less sign";
call charbegin('045, 18, 0, 0, .5[px, ph] + prt/2, 5[px, ph] + prt/2 - 2pa, 0);
cpen;   lft_{10}x_1 = round u;   rt_{10}x_2 = round 11.5u;   x_3 = x_2;
y_2 = good_{10}.5[m, h];   .5[y_2, y_3] = y_1 = good_{10}a;
w_{10} draw 2..1..1..3;                                             % left diagonals
rt_{10}x_5 = round(r - u);   x_6 = x_5;   x_4 - x_1 = x_5 - x_2;   y_4 = y_1,   y_5 = y_2,   y_6 = y_3,
draw 5..4..4..6.                                                   % right diagonals

"Much greater sign";
call charbegin('046, 18, 0, 0, 5[px, ph] + prt/2, .5[px, ph] + prt/2 - 2pa, 0);
cpen;   lft_{10}x_2 = round u:   rt_{10}x_1 = round 11.5u;   x_3 = x_2;
y_2 = good_{10}.5[m, h];   .5[y_2, y_3] = y_1 = good_{10}a;
w_{10} draw 2..1..1..3;                                             % left diagonals
rt_{10}x_4 = round(r - u);   x_6 = x_5;   x_4 - x_1 = x_5 - x_2;   y_4 = y_1,   y_5 = y_2,   y_6 = y_3,
draw 5..4..4..6.                                                   % right diagonals

"Similar or equal sign";
call charbegin('047, 18, 0, 0, px - pe + prt/2 + pa, px - pe + prt/2 - pa, 0);
vpen;   top_{10}y_1 = round(a + (m - e) + eps);   top_{10}y_1 - bot_{10}y_2 = round(m - e),
lft_{10}x_3 = round u;   y_5 = .5[y_1, y_2];   y_3 = y_2;   y_4 = y_1;   x_4 = r - x_3;   x_5 = r - x_5,
call `a zdraw(3, 1.5, 2, 4, w_{10}, w_{10} + deltaw, 7.5u/(e - m));                  % stroke
cpen;   y_6 = y_7;   a - y_6 = round(m - e);   lft_{10}x_6 = round u;   x_7 = r - x_6;
w_{10} draw 6..7.                                                            % bar
```

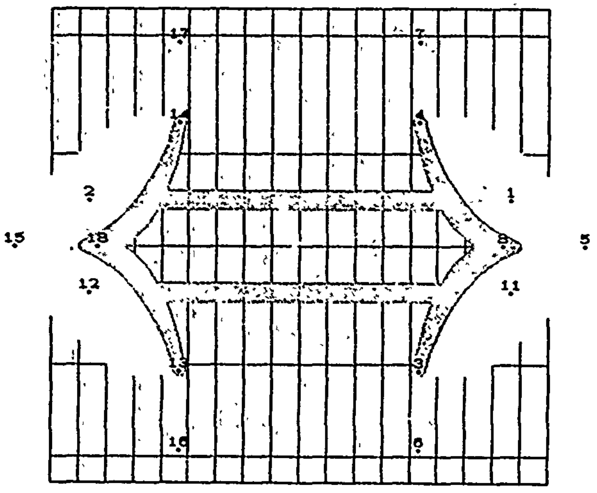




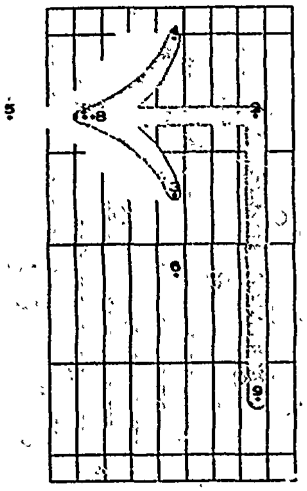


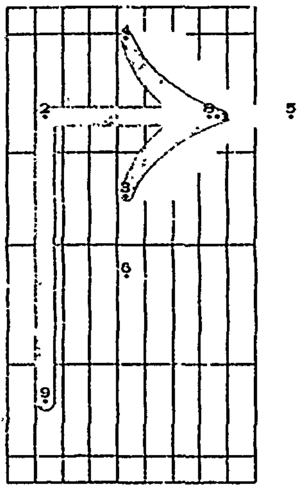
```
"Double leftward arrow";
call charbegin('050, 18, 0, 0, .24ph + .5prt + .5(px − pe) + pa,
                .24ph + .5prt + .5(px − pe) − pa, 0);
cpen;  lft_10 x_1 = x_0 = round u;  rt_10 x_2 = round(r − u);  x_11 = x_1;  x_12 = x_2;
y_5 = y_8 = good_10 a;  y_1 = y_2;  y_11 = y_12;  .5[y_1, y_11] = y_5;  y_1 − y_11 = round(m − e);
w_10 draw 1..2;  draw 11..12;                                                    % bars
hpen;  lft_1 x_8 = x_0;
x_5 − x_8 = x_8 − x_3 = −fixwidth[3u, 6u] − eps;  x_3 = x_4 = x_6 = x_7;
y_3 − y_6 = y_11 − y_3 = y_4 − y_1 = y_7 − y_1 = .24h + eps;
lpen#;  w_10 + w_1 ddraw (5..)8..3(..6), 11..11;               % erase excess at lower left
hpen;  draw (|w_1|5..)8..|w_0|3(..6);                                     % lower point
lpen#;  w_10 + w_1 ddraw (5..~~7~~5..4(..7), 1..1;             % erase excess at upper left
hpen;  draw (|w_1|5..)8..|w_0|4(..7).                                     % upper point

"Double rightward arrow";
call charbegin('051, 18, 0, 0, .24ph + .5prt + .5(px − pe) + pa,
                .24ph + .5prt + .5(px − pe) − pa, 0);
cpen;  lft_10 x_2 = round u;  rt_10 x_1 = x_0 = round(r − u);  x_11 = x_1;  x_12 = x_2;
y_5 = y_8 = good_10 a;  y_1 = y_2;  y_11 = y_12;  .5[y_1, y_11] = y_5;  y_1 − y_11 = round(m − e);
w_10 draw 1..2;  draw 11..12;                                                    % bars
hpen;  rt_1 x_8 = x_0;
x_5 − x_8 = x_8 − x_3 = fixwidth[3u, 6u] + eps;  x_3 = x_4 = x_6 = x_7;
y_3 − y_6 = y_11 − y_3 = y_4 − y_1 = y_7 − y_1 = .24h + eps;
rpen#;  w_10 + w_1 ddraw (5..)8..3(..6), 11..11;              % erase excess at lower right
hpen;  draw (|w_1|5..)8..|w_0|3(..6);                                     % lower point
rpen#;  w_10 + w_1 ddraw (5..)8. 4(..7), 1..1;                % erase excess at upper right
hpen;  draw (|w_1|5..)8..|w_0|4(..7).                                     % upper point

"Double upward arrow";
call charbegin('052, 9, 0, 0, ph, ph − 2pa, 0);
cpen;  top_10 y_1 = y_0 = h;  .5[y_1, y_2] = a;  y_11 = y_1;  y_12 = y_2;
x_0 = x_5 = x_8 = good_10 .5r;  x_1 = x_2;  x_11 = x_12;
.5[x_1, x_11] = x_5;  x_1 − x_11 = round 3.5u;
w_10 draw 1..2;  draw 11..12;                                                   % stems
vpen;  top_7 y_8 = y_0;
lpen#;  2u draw 0..8;  rpen#;  2u draw 0..8;                              % clean the top
y_5 − y_8 = y_8 − y_3 = .24h + eps;  y_3 = y_4 = y_6 = y_7;
x_3 − x_6 = x_12 − x_3 = x_4 − x_1 = x_7 − x_1 = 3u + eps;
lpen#;  2u draw (5..)8..3(..6);                                     % erase excess at left
vpen;  draw (|w_7|5..)8..|w_0|3(. 6);                                      % left point
rpen#;  2u draw (5..)8..4(..7);                                    % erase excess at right
vpen;  draw (|w_7|5..)8..|w_0|4(..7).                                     % right point
```

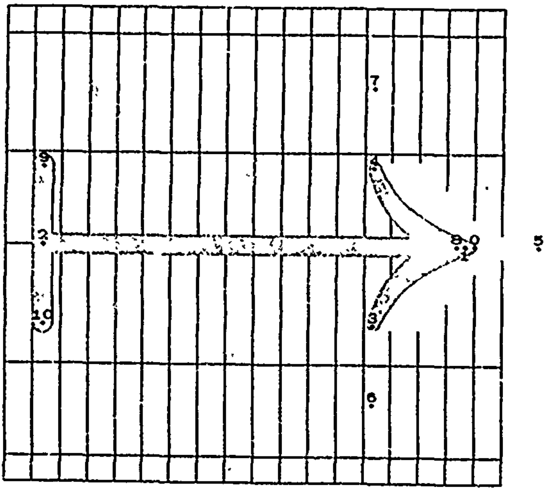




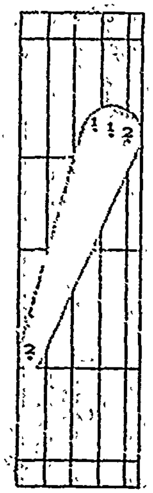
```
"Double downward arrow";
call charbegin('053,9,0,0,ph,ph − 2pa,0);
cpen;   top10y2 = h;   .5[y1,y2] = a,   y0 = bot10y1;   y11 = y1;   y12 = y2;
x0 = x5 = x8 = good10.5r;   x1 = x2;   x11 = x12;
.5[x1,x11] = x5;   x1 − x11 = round 3.5v;
w10 draw 1..2;   draw 11..12;                                        % stems
vpen;   bot7y8 = y0;
lpen#;   2u draw 0..8;   rpen#;   2u draw 0..8;                      % clean the top
y5 − y8 = y8 − y3 = −.24h − eps;   y3 = y4 = y6 = y7,
x3 − x6 = x12 − x3 = x4 − x1 = x7 − x4 = 3u + eps;
lpen#;   2u draw (5..)8..3(..6);                                     % erase excess at left
vpen;   draw (|w7|5..)8..|w0|3(..6);                                 % left point
rpen#;   2u draw (5..)8..4(..7);                                     % erase excess at right
vpen;   draw (|w7|5..)8..|w0|4(..7).                                 % right point

"Double left-and-right arrow";
call charbegin('054,18,0,0,.24ph + .5prt + .5(px − pe) + pa,
                    .24ph + 5prt + .5(px − pe) − pa,0);
cpen;   lft10x2 = x10 = round u;   rt10x1 = x0 = round(r − u);   x11 = x1,   x12 = x2,
y5 = y8 = good10a;   y1 = y2;   y11 = y12;   .5[y1,y11] = y5;   y1 − y11 = round(m − e);
w10 draw 1..2;   draw 11..12;                                        % bars
hpen;   rt1x8 = x0;   lft1x18 = x10;
x5 − x8 = x8 − x3 = x14 − x18 = x18 − x15 = fixwidth[3u,6u] + eps;
x3 = x4 = x6 = x7;   x13 = x14 = x16 = x17;
y3 − y6 = y11 − y3 = y4 − y1 = y7 − y4 = .24h + eps;
y13 = y3;   y14 = y4;   y15 = y5;   y16 = y6;   y17 = y7;   y18 = y8;
rpen#;   w10 + w1 ddraw (5..)8..3(..6), 11..11;                      % erase excess at lower right
hpen;   draw (|w1|5..)8..|w0|3(..6);                                 % lower right point
rpen#,   w10 + w1 ddraw (5..)8..4(..7), 1..1;                        % erase excess at upper right
hpen;   draw (|w1|5..)8..|w0|4(..7);                                 % upper right point
lpen#;   w10 + w1 ddraw (15..)18..13(..16), 12..12;                  % erase excess at lower left
hpen;   draw (|w1|15..)18..|w0|13(..16);                             % lower left point
lpen#;   w10 + w1 ddraw (15..)18..14(..17), 2..2;                    % erase excess at upper left
hpen;   draw (|w1|15..)18..|w0|14(..17).                             % upper left point
```

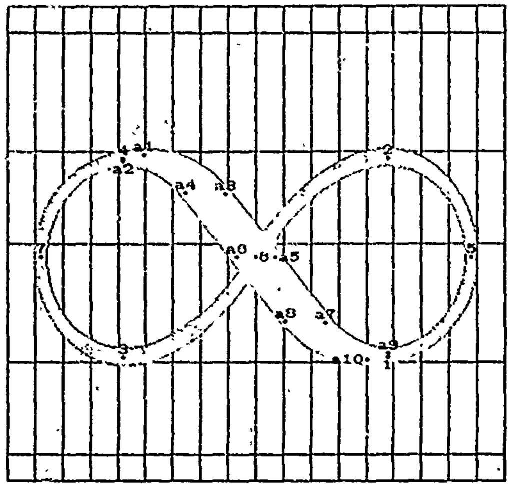


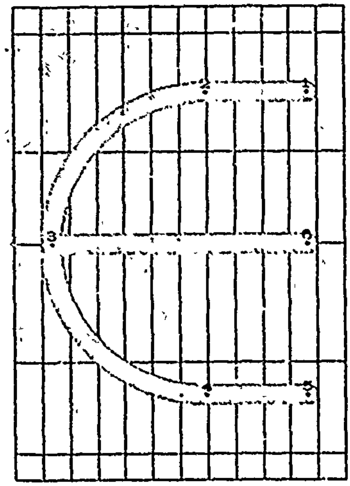


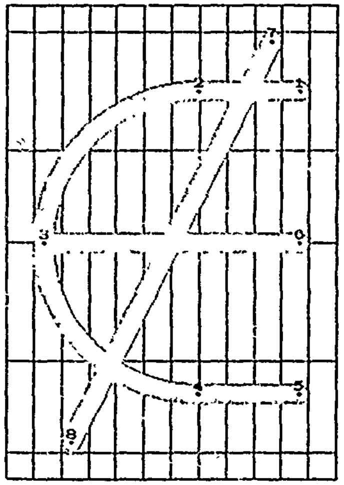


```
"Left shift sign";
call charbegin('055, 9, 0, 0, ph, .5pd, 0);
cpen;   lft_10 x_1 = x_0 = round u;   rt_10 x_2 = round(r - u);
y_1 = y_2 = y_5 = y_8 = good_10 .75h;
w_10 draw 1..2;                                                   % bar
x_9 = x_2;   bot_10 y_9 = -.5d;   draw 2..9;                      % stem
hpen;   lft_1 x_8 = x_0;
x_5 - x_8 = x_8 - x_3 = -3u - eps;   x_3 = x_4 = x_6 = x_7;
y_3 - y_6 = y_6 - y_8 = y_4 - y_8 = y_7 - y_4 = .24h + eps;
lpen#;   w_10 + w_1 draw (5..)8  .3(..6);         % erase excess at lower left
hpen;   draw (|w_1|5..)8..|w_0|3(..6);                            % lower point
lpen#;   w_10 + w_1 draw (5..)8..4(..7);          % erase excess at upper left
hpen;   draw (|w_1|5..)8  .|w_0|4(..7).                           % upper point

"Right shift sign";
call charbegin('056, 9, 0, 0, ph, .5pd, 0);
cpen;   lft_10 x_2 = round u;   rt_10 x_1 = x_0 = round(r - u);
y_1 = y_2 = y_5 = y_8 = good_10 .75h;
w_10 draw 1..2;                                                   % bar
x_9 = x_2;   bot_10 y_9 = -.5d;   draw 2..9;                      % stem
hpen;   rt_1 x_8 = x_0;
x_5 - x_8 = x_8 - x_3 = 3u + eps;   x_3 = x_4 = x_6 = x_7;
y_3 - y_6 = y_6 - y_8 = y_4 - y_8 = y_7 - y_4 =  24h + eps,
rpen#;   w_10 + w_1 draw (5..)8  .3(..6);         % erase excess at lower right
hpen;   draw (|w_1|5..)8..|w_0|3(..6);                            % lower point
rpen#;   w_10 + w_1 draw (5..)8..4(..7);          % erase excess at upper right
hpen;   draw (|w_1|5..)8..|w_0|4(..7).                            % upper point

"Maps-to relation";
call charbegin('057, 18, 0, 0, .24ph + 5prt + pa, .24ph + 5prt - pa, 0);
cpen;   lft_10 x_2 = round u;   rt_10 x_1 = x_0 = round(r - u);
y_0 = y_1 = y_2 = y_5 = y_8 = good_10 a;
w_10 draw 1..2;                                                   % bar
hpen;   rt_1 x_8 = x_0;
x_5 - x_8 = x_8 - x_3 = fixwidth[3u, 6u] + eps;   x_3 = x_4 = x_6 = x_7;
y_3 - y_6 = y_6 - y_8 = y_4 - y_8 = y_7 - y_4 =  .24h + eps;
rpen#;   w_10 + w_1 draw (5.  )8..3(  6),         % erase excess at lower right
hpen;   draw (|w_1|5.  )8  |w_0|3(..6);                           % lower point
rpen#,   w_10 + w_1 draw (5..)8..4(..7),          % erase excess at upper right
hpen;   draw (|w_1|5  .)8.  |w_0|4(  .7);                         % upper point
x_9 = x_10 = x_2;   y_9 = y_6;   y_10 = y_3;
cpen;   w_10 draw 9..10.                                          % stem
```

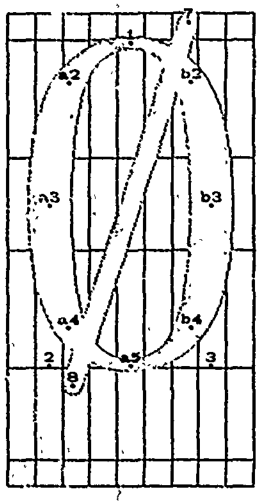


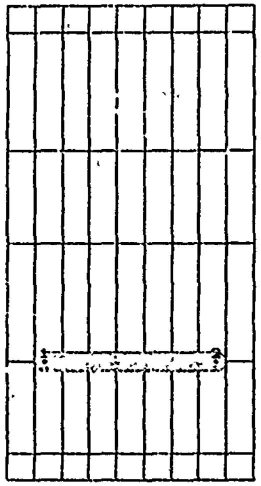


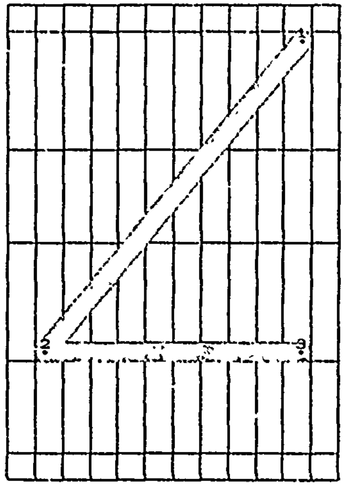


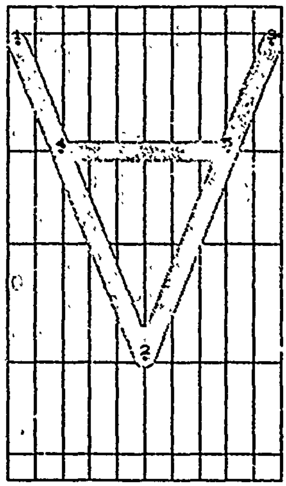


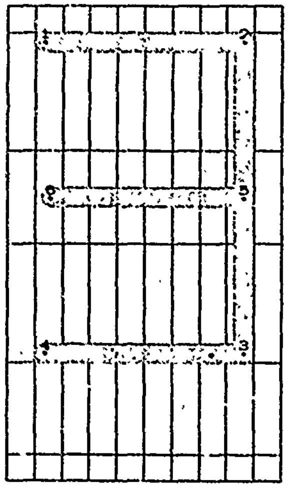
```
"Prime symbol (intended as superscript only)";
call charbegin('060, 4.5, 0, 0, .8ph, 0, 0);
new w98, w99,   w98 = round .5[w0, w1];   w99 = round(bold + 2deltaw);
cpen;   top99y1 = round .8h;   rt99x1 = r;   bot98y2 = 0;   lft98x2 = 0;
call cdraw(1, 2, 99, 98).                                                    % diagonal

"Infinity";
call charbegin('061, 18, 0, 0, px, 0, .5px·slant − .5pu);
new w98, w99;   w99 = round .25[w6, w7];   w98 = 2[w1, w2];
vpen;   top99y2 = m + oo;   bot99y1 = −oo;   y2 = y4;   y1 = y3;
x1 = x2;   x3 = x4;   y5 = y6 = y7 = 5[y1, y2];
lft0x7 = round u;   rt0x5 = round(r − u);   x6 = 5[x7, x5];
new ss, mss;                                              % reciprocal slope at center
if w6 = w98·   mss = ss;   ss = −u/m;
else:   mss = .75ss;   ss = −6u/m;
fi,
call 'a zdraw(7, 4, 6, 1, 5, w99, w98, ss);          % lower right and upper left strokes
w99 draw 5{0, 1}   2{−1, 0} .. 6{mss, −1} .  3{−1, 0}  .
     7{0, 1}.                                        % upper right and lower left strokes

"Element sign";
call charbegin('062, 12, 0, 0, 5[px, ph] + prt/2, .5[px, ph] + prt/2 − 2pa, 0),
cpen;   rt10x1 = round(r − u);   lft10x3 = round u;
x5 = x6 = x1;   x2 = x4 = .5(r + 2u);
y1 = y2 = good10(.5[m, h]),   y3 = y6 = a;   y4 = y5,   5[y5, y1] = y6;
w10 draw 1 .. 2{−1, 0} .. 3{0, −1} .. 4{1, 0} .. 5;                          % bowl
draw 3 .. 6.                                                                  % bar

"Nonelement sign";
call charbegin('063, 12, 0, 0, ph, ph − 2pa, 0);
cpen;   rt10x1 = round(r − u);   lft10x3 = round u;
x5 = x6 = x1;   x2 = x4 = .5(r + 2u);
y1 = y2 = good10(.5[m, h]);   y3 = y6 = a,   y4 = y5,   5[y5, y1] = y6;
w10 draw 1 .. 2{−1, 0} .. 3{0, −1} .. 4{1, 0} .. 5,                          % bowl
draw 3 .. 6;                                                                  % bar
rt10x7 = round(r − 2u);   lft10x8 = round 2u;   top10y7 = h;   5[y7, y8] = a;
draw 7 .. 8.                                                             % diagonal
```

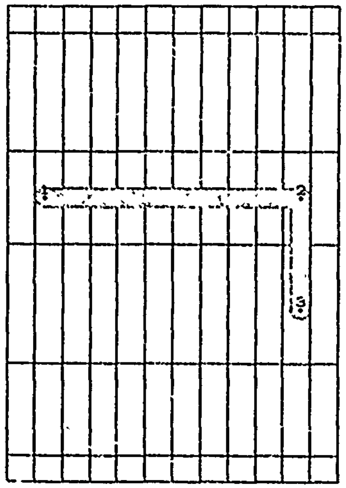




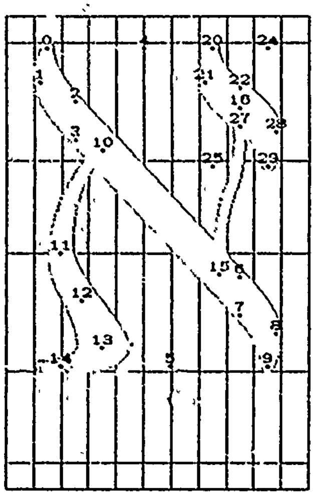




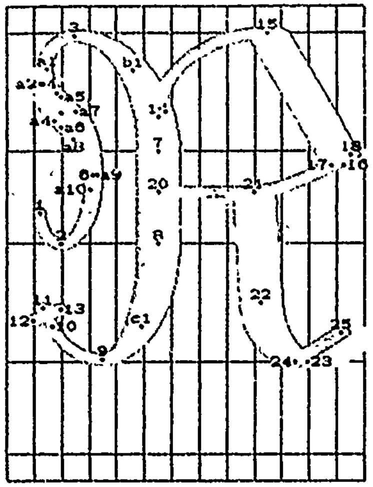




```
"Empty set symbol";
call charbegin('064, 9, 0, 0, $ph + pb$, $pb$, 0);
if fixwidth = 0:   new save;   save = sqrttwo;   new sqrttwo;
      sqrttwo = sqrt(1.23114413save);                          % the constant is $2^{3/10}$
fi;
hpen;
if $w_2 > 1.5u$:   $\text{lft}_2 x_2$ = round .75$u$;
else:   $x_2 = \text{good}_2\, 1\,5u$;
fi;
                                                       % axis of left-right symmetry
$x_1 = r - x_1$;
$x_3 = r - x_2$;   $\text{top}_0 y_1 = h + oo$;   $\text{bot}_0 y_2 = -oo$;   $y_1 = y_2$;
call `a darc(1, 2, $w_2$);   call `b darc(1, 3, $w_2$);                 % bowl
if fixwidth = 0:   new sqrttwo;   sqrttwo = save;
fi;
cpen;   $\text{rt}_{10} x_7$ = round($r - 2u$);   $\text{lft}_{10} x_8$ = round 2$u$;   $\text{top}_{10} y_7 = h + b$,   $\text{bot}_{10} y_8 = -b$,
$w_{10}$ draw 7..8.                                              % diagonal

"Underline";
call charbegin('065, 9, 0, 0, 0, 0, 0);
cpen,   $\text{lft}_{10} x_1$ = round $u$;   $x_2 = r - x_1$,   $y_1 = y_2 = 0$;
$w_{10}$ draw 1..2.                                              % bar

"Angle sign";
call charbegin('066, 12, 0, 0, $ph$, 0, 0);
cpen;   $\text{lft}_{10} x_2$ = round $u$;   $x_1 = x_3 = r - x_2$;   $\text{top}_{10} y_1 = h$,   $\text{bot}_{10} y_2 = 0$;   $y_3 = y_2$;
$w_{10}$ draw 1..2..2..3.                                  % diagonal and bar

"Universal quantifier";
call charbegin('070, 10, 0, 0, $ph$, 0, 0);
cpen;   $\text{lft}_{10} x_1 = 0$;   $x_2 = \text{good}_{10} .5r = .5[x_1, x_3]$;
$\text{top}_{10} y_1 = h$;   $y_3 = y_1$;   $\text{bot}_{10} y_2 = -o$,   $y_4 = y_5 = \text{good}_{10} m$;
new $aa, bb$;   $x_4 = aa[x_1, x_2]$;   $y_4 = aa[y_1, y_2]$;   $x_5 = bb[x_3, x_2]$;   $y_5 = bb[y_3, y_2]$;
$w_{10}$ draw 1..2   2..3;                                        % diagonals
draw 4..5.                                                       % bar

"Existential quantifier";
call charbegin('071, 10, 0, 0, $ph$, 0, 0);
cpen,   $\text{lft}_{10} x_1$ = round $u$;   $\text{rt}_{10} x_2$ = round($r - u$);   $x_3 = x_5 = x_2$,   $x_4 = x_6 - .25u = x_1$,
$\text{top}_{10} y_1 = h$;   $\text{bot}_{10} y_4 = 0$;   $y_2 = y_1$;   $y_5 = y_6 = .5[y_1, y_4]$,   $y_3 = y_4$.
$w_{10}$ draw 1..2..2..3..3..4;                  % upper bar, stem, lower bar
draw 5..6.                                                % middle bar

"Logical NOT";
call charbegin('072, 12, 0, 0, $px$, 0, 0);
cpen;   $\text{lft}_{10} x_1$ = round $u$;   $x_2 = x_3 = r - x_1$;
$y_1 = y_2 = \text{good}_{10} .5[e, m]$;   $y_2 - y_3 = 1.2(m - e)$;
$w_{10}$ draw 1..2..2..3.                                    % bar and stem
```

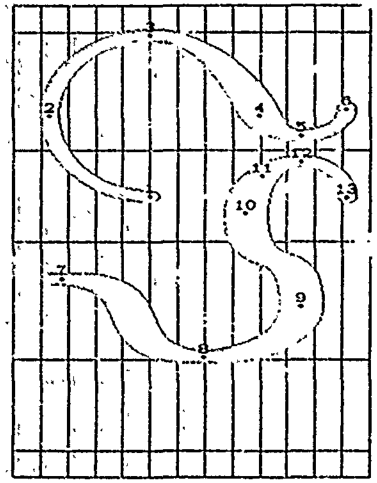


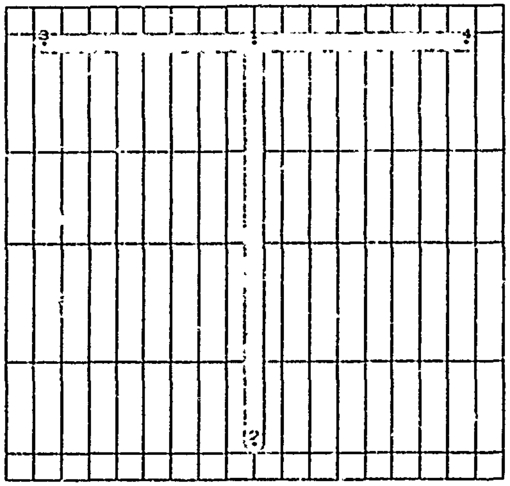
```
"Hebrew letter aleph",
call charbegin('073, 11, 0, 0, ph, 0, 0);
vpen;  lft6x1 = round u;  y1 = ⅔[m,h],
x1 + x5 = x3 + x6 = x2 + x7 = x0 + x9 = x4 + x8 = r;   x2 = x1 = 2.5u;
new aa.  x2 = aa[x1,x8];  y50 = aa[y1,y8];
top5y50 = top0y2;  bot5y50 = bot6y1;
x0 = 1.5u;  top6y0 = h;  y1 = y0;  x4 = 5u;
y1 + y5 = y3 + y6 = y2 + y7 = y4 + y8 = y0 + y9 = h,
w6 ddraw 0..0{0,−1}..2{x8 − x1, y8 − y1}..6{x8 − x1, y8 − y1}  8{0, −1}  9(  5),
    (4..)0..1{0,−1}..3{x8 − x1, y8 − y1}..7{x8 − x1, y8 − y1}..
        9{0,−1}..9;                                              % long diagonal
hpen,  x10 = 3.5u;  new aa;  x10 = aa[x1,x8],  y10 = aa[y1,y8];
new w90;  w90 = round .5[w0,w1];
x11 = good90 2u;  y11 = e;
x12 = .5[x11,x13];  y12 = .5[y11,y13];
x13 = good5 3.5u;  y13 = .2e;
x14 = good5 2u;  bot5y14 = 0;
draw |w0#|10{y8 − y1, x1 − x8} .|w90|11{0,−1}..
    |.5[w90,w5]|12{1.5(x13 − x11), y13 − y11}..
    |w5#|13{0,−1} .14{−1,0};                                     % lower left stroke
x15 = 7.75u;  new aa; . x15 = aa[x1,x8];  y15 = aa[y1,y8];
x16 = .5[x21,x28];  y16 = .5[y21,y28];
vpen;  lft6x21 = round 7u;  y21 = y1,
x20 + x29 = x21 + x28 = x22 + x27 = x24 + x25;  x28 = x8,
y20 + y29 = y21 + y28 = y22 + y27 = y24 + y25;  y28 = .25[m,h],
top5y16 = top6y22;  x22 = x27;
x20 = 7.5u;  x24 = 9.5u;  y20 = y24 = y0;
w6 ddraw 20..20{0,−1}..22{x28 − x21, y28 − y21}. 28{0,−1}  29(  25),
    (24..)20..21{0,−1}. 27{x28 − x21, y28 − y21}..
        29{0,−1}..29;                                            % short diagonal
draw 15{0,1}. 16{0,1}.                                           % link
```

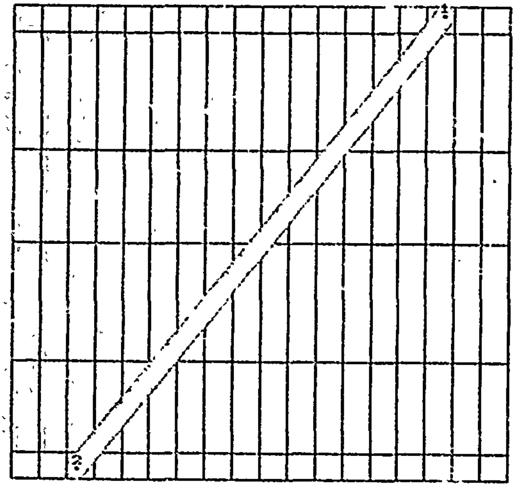


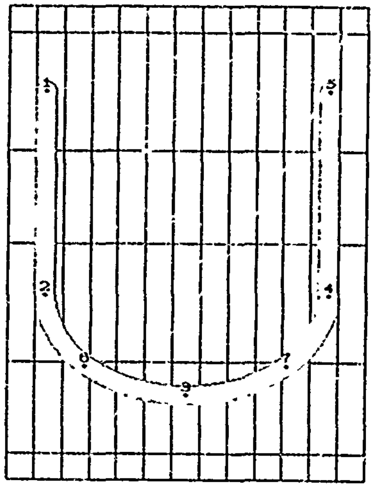
a3
5

```
"Upper case Fraktur R";
call charbegin( 074, 13, 0, 0, ph, 0, 0);
new w99;   w99 = round .25[w0, w1];
hpen;   lft0x1 = round u;   y1 = 1/3[e, m],   x2 = 2u;   y2 = e;
w0 draw 1{0, -1}..2{1, 0},                                   % point of upper left flourish
x3 = 2.5u;   top0y3 = h + oo;   lft99x4 = round u;
x5 = 2u;   y5 = 1/3[m, h];   rt99x6 = round 3.5u;
call 'a sdraw(3, 4, 5, 6, 2, w99, w8, -(h - e)/(8u));                        % flourish
x7 = x8 = good1 5.5u;   y7 = m;   y8 = e;
call 'b arc(3, 7, w1);                                                   % upper link
w1 draw 7..8;                                                                 % stem
x9 = 3.5u;   bot0y9 = -oo;   call 'c arc(9, 8, w1);                      % lower link
x10 = 2/3u;   y10 = .3e;   x11 = 1/3u;
x12 = u;   y12 = .35e;   x13 = 2u;   y13 = .45e;
new aa;   x11 = x10 + aa(y12 - y13);
y11 = y10 + aa(x13 - x12);                                      % perpendicular to 12. 13
w0 draw 9{-1, 0}. 10{x11 - x10, y11 - y10} .11;                              % tail
draw 12..13;                                                                 % cross
x14 = x7;   y14 = .75h;   x15 = 9.5u;   top99y15 = h + o;
draw 14{0, 1}..15{1, 0},                                                 % top of bowl
lft1x16 = 11.5u;   y16 = .6h;
w1 draw 15..16;                                                     % diagonal of bowl
lft99x17 = lft1x16;   y17 = y16;
new aa, bb;   rt99x18 = aa[rt1x15, rt1x16];   y18 = aa[y15, y16];
x18 = x17 + bb(y15 - y16);   y18 = y17 + bb(x16 - x15);      % perpendicular to 15 16
rpen#;   w1 draw 17..18;                                                 % erase excess
x20 = x7;   y20 = y21 = .52h;   x21 = 9u;
hpen;   w99 draw 20..21{1, 0}..17{x18 - x17, y18 - y17}. 18,          % bottom of bowl
x22 = 9.25u;   y22 = .5e;   lft99x23 = lft1x23;   bot1y23 = -o,
x24 = 10.5u;   y24 = y23;   rt99x25 = 12.5u;   y25 = e/4;
w1 draw 21..22{x22 - x21, y22 - y21} .23{1, 0};                       % lower diagonal
rpen#;   w1 draw 24..25;                                % erase excess at lower right
hpen;   w99 draw 24..25.                              % point of lower right diagonal
```

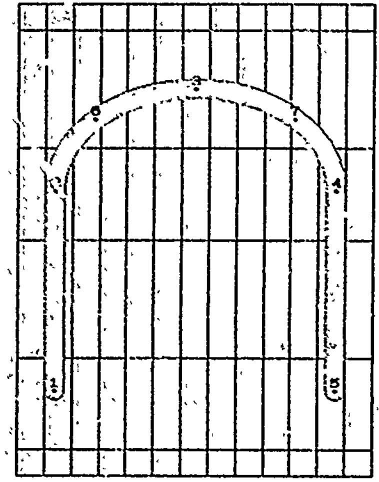


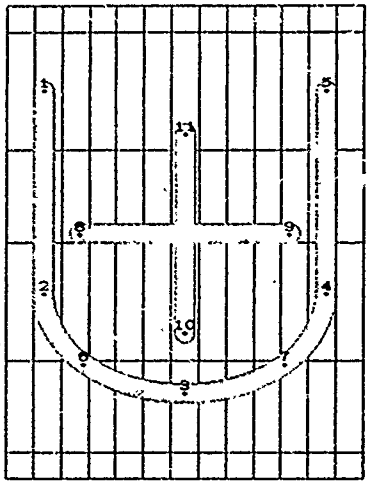


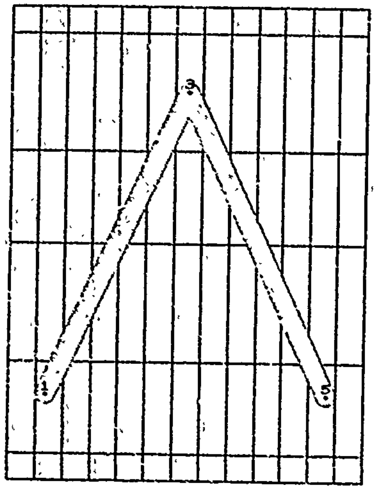


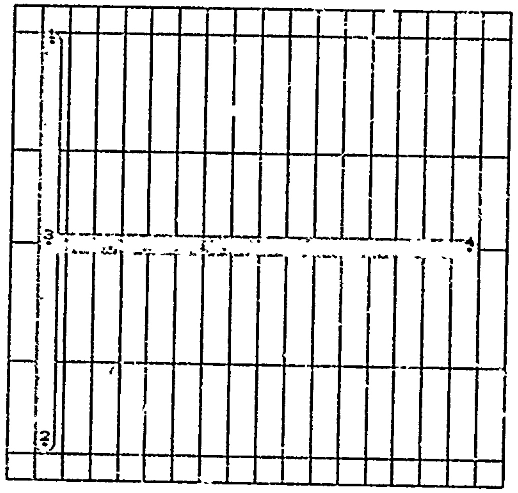


```
"Upper case Fraktur I";
call charbegin('075, 13, 0, 0, ph, 0, 0);
% (this letter extended to be same width as the R)
new w99;   w99 = round 25[w0, w1];
hpen;   x2 = 5u;   y1 = good0 5h,   lft99x2 = round u,   y2 = 75h;
x3 = x1;   top99y3 = h + oo;
w99 draw 1{-1,0} . 2{0,1} . 3{1,0};                                  % shoulder
x4 = 9u;   y4 = .75h,   x5 = 10 5u,   bot99y5 = 7h + 1;
rt99x6 = 12.5u;   bot99y6 = 75h + 1;
draw |w99#|3{1,0} . |w1#|4{6u, -h} . . |w99#|5{1,0} . 6{0,1},        % upper stroke
lft1x7 = round u;   y7 = good0 .25h;
x8 = 7u;   bot1y8 = -oo,
x9 = good1 10 5u;   y9 = h/6;
x10 = good1 8 5u;   y10 = 45h,
x11 = 1/sqrttwo[x12, x10];   y11 = 1/sqrttwo[y10, y12].
x12 = x6;   top99y12 = 625h;
rt99x13 = round 12 5u;   y13 = 5h;
draw |w1|7{1,0}   8{1,0}   9{0,1} . |w1#|10{0,1}
     |⅔[w99, w1]|11{x12 - x10, y12 - y10}   |w99#|12   13{0, -1}.     % lower stroke

"Lattice top",
cpen;
if fixwidth = 0:   if pa + 8pu > ph:
          call charbegin('076, 18, 0, 0, ph, ph   2pa, 0),   top10y1 = h,
     else:   call charbegin('076, 18, 0, 0, 8pu + pa, 8pu - pa, 0),   top10y1 = a + 8u,
     fi;
else:   call charbegin('076, 9, 0, 0, 3.5pu + pa, 3 5pu - pa, 0).   top10y1 = a + 3 5u;
fi;
 5[y1, y2] = a;   x1 = x2 = 5r;
lft10x3 = round u;   x4 = r - x3,   y3 = y4 = y1,
w10 draw 1..2;                                                        % stem
draw 3..4.                                                            % bar

"Zero-width slash to negate a relation";
call charbegin('100, 18, 0, 0, ph + pb, ph + pb - 2pa, 0);
charwd 0;   chardw 0;
cpen;   rt10x1 = round(r - 2u),   lft10x2 = round 2u;
top10y1 = h + b,   5[y1, y2] = a,
w10 draw 1. 2.                                                        % diagonal

"Set union sign",
call charbegin('133, 13, 0, 0, ph, ph   2pa, 0),
cpen;   lft10x1 = round u;   x2 = x1,   x4 = r - x1,   x5 = x4,   x3 = r - x1,
y1 = good10( 5[m, h]);   .5[y1, y3] = a,   y2 = y4 = ⅓[y1, y3],   y5 = y1.
call qcirc(3, 6, 2, w10);   call qcirc(3, 7, 4, w10);                 % cup
w10 draw 1..2;   draw 4..5.                                           % stems
```

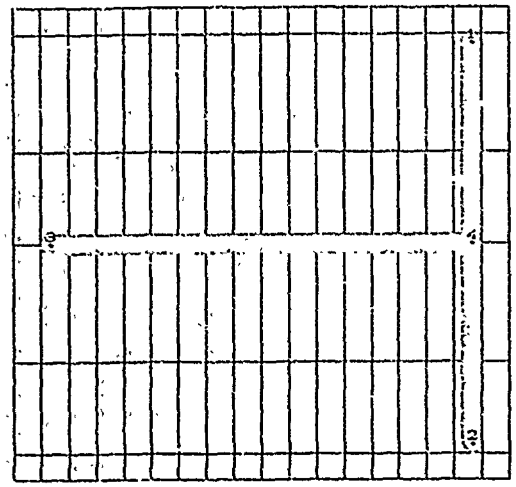


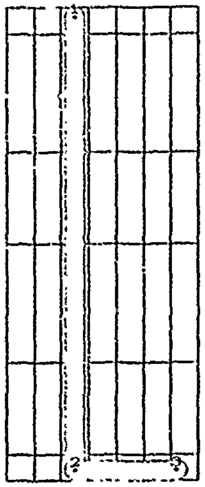


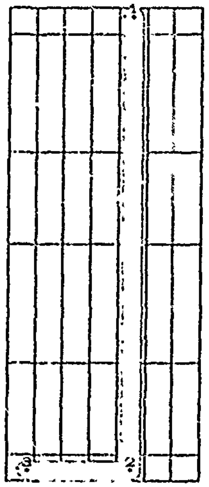


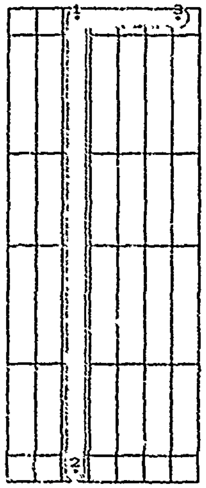


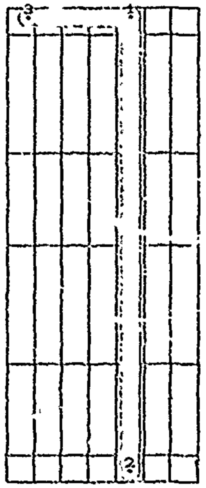
```
"Set intersection sign";
call $charbegin$('134, 13, 0, 0, $ph$, $ph - 2pa$, 0);
cpen;   lft$_{10}x_1$ = round $u$;   $x_2 = x_1$;   $x_3 = r - x_1$;   $x_4 = x_5 = r - x_1$;
$y_3$ = good$_{10}$(.5[$m, h$]);   .5[$y_1, y_3$] = $a$;   $y_2 = y_4 = \frac{2}{3}[y_1, y_3]$   $y_5 = y_1$;
call $qcirc$(3, 6, 2, $w_{10}$);   call $qcirc$(3, 7, 4, $w_{10}$);                      % cap
$w_{10}$ draw 1..2;   draw 4..5.                                                      % stems

"Multiset union sign";
call $charbegin$('135, 13, 0, 0, $ph$, $ph - 2pa$, 0);
cpen;   lft$_{10}x_1$ = round $u$;   $x_2 = x_1$;   $x_3 = r - x_1$;   $x_4 = x_5 = r - x_1$,
$y_3$ = good$_{10}$(.5[$m, h$]);   .5[$y_1, y_3$] = $a$,   $y_2 = y_4 = \frac{2}{3}[y_1, y_3]$,   $y_5 = y_1$;
call $qcirc$(3, 6, 2, $w_{10}$);   call $qcirc$(3, 7, 4, $w_{10}$);                      % cup
$w_{10}$ draw 1..2;   draw 4..5;                                                      % stems
$y_8 = y_9$ = .47[$y_1, y_3$];   $x_8 = r - x_9 = x_1 + 1.75w_{10} - eps$;
$x_{10} = x_{11} = x_3$;   .5[$y_{10}, y_{11}$] = $y_8$,   $y_{11} - y_{10} = x_9 - x_8$;
draw 8..9;   draw 10..11.                                                   % enclosed plus sign

"Lattice infimum (logical AND) sign";
call $charbegin$('136, 13, 0, 0, $ph$, $ph - 2pa$, 0);
cpen;   lft$_{10}x_1$ = round $u$;   $x_3 = r - x_3$;   $x_5 = r - x_1$;
$y_3$ = good$_{10}$(.5[$m, h$]);   .5[$y_1, y_3$] = $a$;   $y_5 = y_1$;
$w_{10}$ draw 1..3 .3..5.                                                       % diagonals

"Lattice supremum (logical OR) sign";
call $charbegin$('137, 13, 0, 0, $ph$, $ph - 2pa$, 0);
cpen;   lft$_{10}x_1$ = round $u$;   $x_3 = r - x_3$;   $x_5 = r - x_1$;
$y_1$ = good$_{10}$(.5[$m, h$]);   .5[$y_1, y_3$] = $a$;   $y_5 = y_1$;
$w_{10}$ draw 1..3 .3..5.                                                       % diagonals

"Left turnstile";
cpen;
if $fixwidth$ = 0:   if $pa + 8pu > ph$.
          call $charbegin$('140, 18, 0, 0, $ph$, $ph - 2pa$, 0);   top$_{10}y_1 = h$,
    else:   call $charbegin$('140, 18, 0, 0, $8pu + pa$, $8pu - pa$, 0);   top$_{10}y_1 = a + 8u$;
    fi;
else:   call $charbegin$('140, 9, 0, 0, $3.5pu + pa$, $3.5pu - pa$, 0);   top$_{10}y_1 = a + 3.5u$,
fi;
.5[$y_1, y_2$] = $a$;   $x_1 = x_2 = x_3$;
lft$_{10}x_3$ = round $u$;   $x_4 = r - x_3$,   $y_4 = y_3 = a$;
$w_{11}$ draw 1..2;                                                             % stem
draw 3..4.                                                                      % bar
```

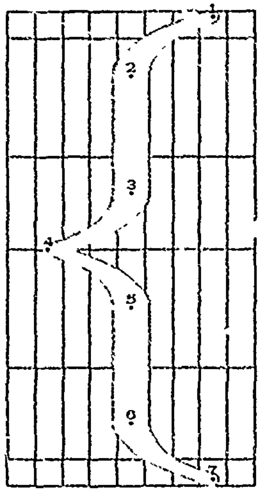




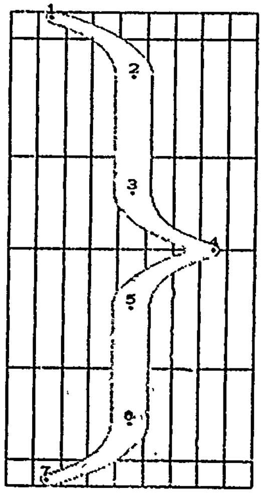


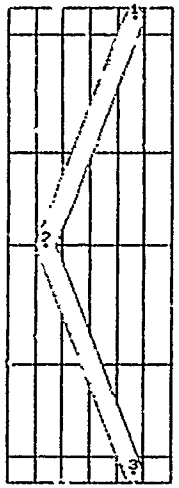


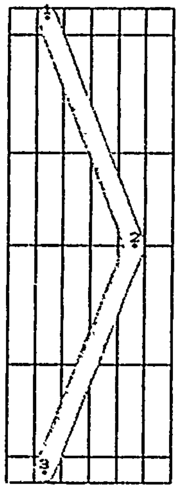


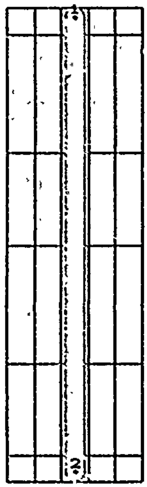


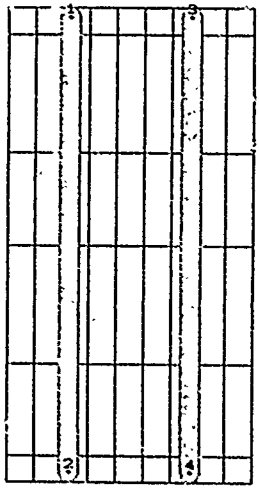
```
"Right turnstile";
cpen;
if fixwidth = 0:   if pa + 8pu > ph:
          call charbegin('141, 18, 0, 0, ph, ph - 2pa, 0);   top_10 y_1 = h;
     else.   call charbegin('141, 18, 0, 0, 8pu + pa, 8pu - pa, 0);   top_10 y_1 = a + 8u;
     fi;
else   call charbegin('141, 9, 0, 0, 3 5pu + pa, 3 5pu - pa, 0),   top_10 y_1 = a + 3.5u,
fi,
.5[y_1, y_2] = a;   x_1 = x_2 = x_1;
lft_10 x_3 = round u;   x_4 = r - x_3;   y_3 = y_4 = a;
w_10 draw 1 . 2;                                                          % stem
draw 3 . 4.                                                                % bar

"Left floor bracket";
call charbegin('142, 7, 0, 0, ph + pb, ph + pb - 2pa, 0);
cpen,   x_1 = x_2 = good_10 2 5u;   x_3 = x_1 + 3.75u + eps;
top_10 y_1 = h + b;   5[y_1, y_2] = a;   y_3 = y_2;
w_10 draw 1   2..2..3.                                              % stem and bar

"Right floor bracket";
call charbegin('143, 7, 0, 0, ph + pb, ph + pb - 2pa, 0),
cpen,   x_1 = x_2 = good_10(r - 2.5u);   x_3 = x_1 - 3 75u - eps,
top_10 y_1 = h + b;   5[y_1, y_2] = a;   y_3 = y_2;
w_10 draw 1..2..2..3.                                               % stem and bar

"Left ceiling bracket";
call charbegin('144, 7, 0, 0, ph + pb, ph + pb - 2pa, 0);
cpen;   x_1 = x_2 = good_10 2.5u,   x_3 = x_1 + 3.75u + eps;
top_10 y_1 = h + b;   .5[y_1, y_2] = a,   y_3 = y_1;
w_10 draw 3 .1   1..2.                                              % bar and stem

"Right ceiling bracket":
call charbegin('145, 7, 0, 0, ph + pb, ph + pb   2pa, 0),
cpen;   x_1 = x_2 = good_10(r - 2.5u),   x_3 = x_1 - 3.75u - eps;
top_10 y_1 = h + b,   5[y_1, y_2] = a;   y_3 = y_1;
w_10 draw 3..1..1..2.                                               % bar and stem

"Left brace",
call charbegin('146, 9, 0, 0, ph + pb, ph + pb - 2pa, (ph + pb) slant + 5pw - pu),
hpen,   x_2 = x_3 = x_5 = x_6 = good_1 5r;   x_1 - x_2 = x_2 - x_4 = 3u + eps,   x_1 = x_7,
top_0 y_1 = h + b,   y_4 = .5[y_1, y_7] = 5[y_2, y_6] = 5[y_3, y_5] - good_0 a,
y_1 - y_2 = y_3 - y_4 = (y_1 - y_4)/4,
draw |w_0#|1{3(x_2 - x_1), y_2 - y_1}   |w_1#|2{0, -1}   |w_1#|3{0, - 1}
     |w_0#|4{3(x_4 - x_3), y_4 - y_3},                                 % upper stem
draw |w_0#|7{3(x_6 - x_7), y_6 - y_7}..|w_1#|6{0, 1} .|w_1#|5{0, 1}..
     |w_0#|4{3(x_4 - x_5), y_4 - y_5}.                                 % lower stem
```

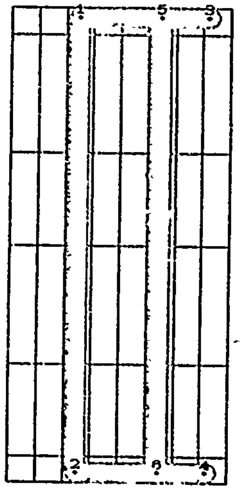


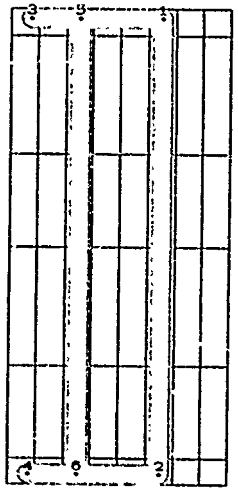




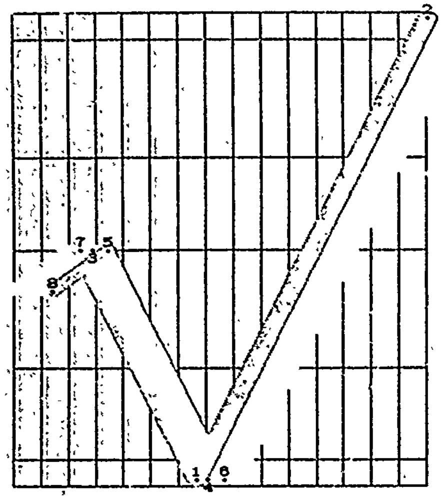


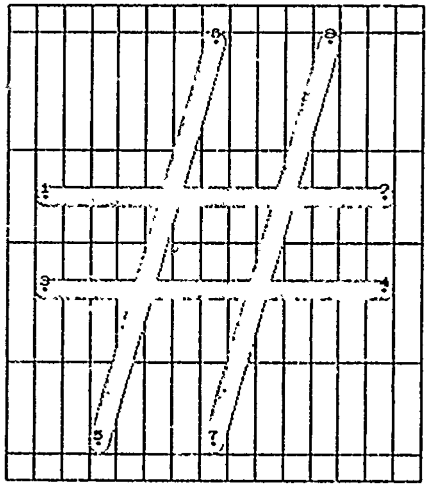


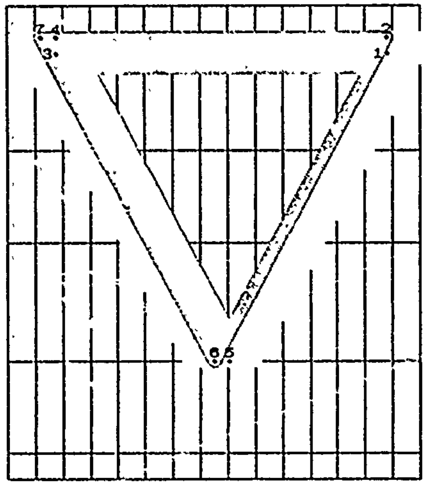




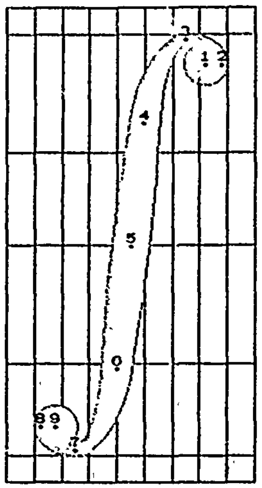
```
"Right brace";
call charbegin('147, 9, 0, 0, ph + pb, ph + pb − 2pa, (ph + pb) slant + 5pwi − 4pu);
hpen;   x2 = x1 = x5 = x6 = good1 5r;   x1 − x2 = x2 − x1 = −3u − eps,   x1 = x7,
top0y1 = h + b;   y1 = .5[y1, y7] = .5[y2, y6] = 5[y3, y5] = good0a;
y1 − y2 = y3 − y1 = (y1 − y1)/4;
draw |w0#|1{3(x2 − x1), y2 − y1} . |w1#|2{0, −1} . . |w1#|3{0, −1} . .
     |w0#|4{3(x1 − x1), y1 − y1};                                      % upper stem
draw |w0#|7{3(x6 − x7), y6 − y7} . |w1#|6{0, 1} . . |w1#|5{0, 1} .
     |w0#|4{3(x1 − x5), y1 − y5}.                                      % lower stem

"Left angle bracket";
call charbegin('150, 6, 0, 0, ph + pb, ph + pb − 2pa, 0);
cpen;   rt10x1 = round(r − u);   x1 = x1,   lft10x2 = round fixwidth[u, 7u];
top10y1 = h + b;   .5[y1, y3] = y2 = good10a;
w10 draw 1 . . 2 . . 2 . . 3.                                          % diagonals

"Right angle bracket";
call charbegin('151, 6, 0, 0, ph + pb, ph + pb − 2pa, 0);
cpen;   rt10(r − x1) = round(r − u);   x1 = x1,   lft10(r − x2) = round fixwidth[u, 7u];
top10y1 = h + b;   5[y1, y3] = y2 = good10a;
w10 draw 1 . . 2 . 2 . . 3.                                            % diagonals

"Vertical line (absolute value or length)";
call charbegin('152, 5, 0, 0, ph + pb, ph + pb − 2pa, 0);
cpen;   x1 = x2 = good10.5r,   top10y1 = h + b,   5[y1, y2] = a,
w10 draw 1 . . 2.                                                      % stem

"Double vertical line (norm or cardinality)";
call charbegin('153, 9, 0, 0, ph + pb, ph + pb − 2pa, 0);
cpen;   x1 = x2 = good10.25r;   top10y1 = h + b;   5[y1, y2] = a;
x3 = x1 = r − x1;   y3 = y1;   y1 = y2;
w10 draw 1 . . 2;   draw 3 . 4                                         % stems

"Double left bracket";
call charbegin('154, 8, 0, 0, ph + pb, ph + pb − 2pa, 0);
cpen;   x1 = x2 = good10 2 5u;   x1 = x1 = x1 + 4 75u + eps,   x5 = x6 = x1 + round 3u,
top10y1 = h + b;   5[y1, y2] = a;   y3 = y5 = y1;   y1 = y6 = y2,
w10 draw 3   1 . 1 . . 2 . . 2   4;                                    % bars and left stem
draw 5 . . 6.                                                          % right stem

"Double right bracket";
call charbegin('155, 8, 0, 0. ph + pb, ph + pb − 2pa, 0);
cpen;   x1 = x2 = good10(r − 2 5u);
x3 = x1 = x1 − 4.75u − eps;   x5 = x6 = x1 − round 3u;
top10y1 = h + b;   .5[y1, y2] = a;   y3 = y5 = y1;   y1 = y6 = y2;
w10 draw 3 . . 1 . . 1 .  2 . . 2 . . 4;                                % bars and right stem
draw 5 . . 6.                                                          % left stem
```

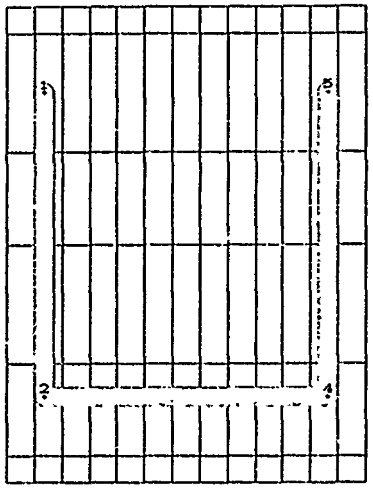




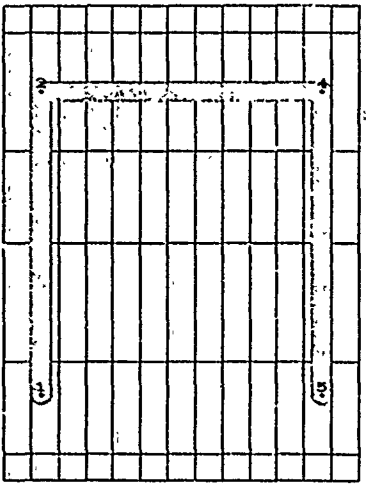


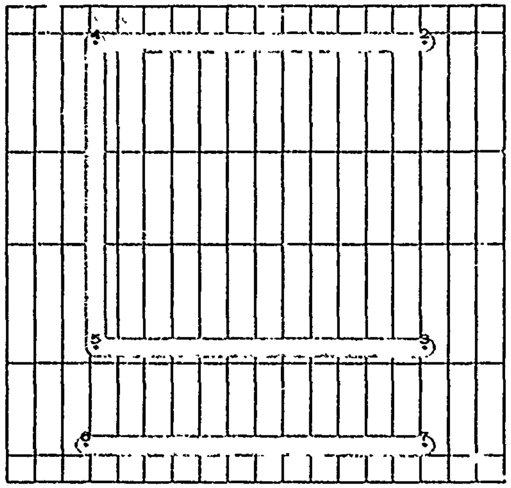
```
"Radical sign";
call charbegin('160, 15, 0, 0, ph + pb, ph + pb − 2pa, 0);
hpen;   x1 = good10(10/3u);   x2 = r + 1,   top10y2 = h + b,   .5[y1, y2] = a,
y3 = y5 = y7 = good6a;   y1 = y4 = y6, .
x7 = 1.5[x2, x1];   lft10x7 = lft2x3;   rt2x3 = rt0x5;
lft10x1 = lft2x4;   rt2x1 = rt0x6;
x8 = x7 − u;   new aa;   x8 = aa[x5, x2];   y8 = aa[y5, y2];
hpen,   w2 draw 3 .4;                                              % left diagonal
w10 draw 7..4;   w0 draw 5   6;                                 % sharpen the corners
lpen#;   w2 draw 8. 5;                                      % erase excess at upper left
hpen;   w0 draw 8..5;                                                        % serif
rpen#;   w2 draw 1 .2;                                     % erase excess at lower right
hpen;   w10 draw 1..2.                                                % right diagonal

"Sharp symbol (number sign or hash mark)";
call charbegin('161, 15, 0, 0, ph, ph − 2pa, 0);
cpen;   lft10x1 = round u;   x3 = x1;   x2 = x4 = r − x1;
y1 = y2;   y3 = y4;   y1 − y3 = round(m − c),   .5[y1, y3] = a,
w10 draw 1 .2;                                                       % upper bar
draw 3..4;                                                           % lower bar
x5 − 2u = x1;   x8 + 2u = x2;   x6 − x5 = x8 − x7;   x6 − x5 = fixwidth[0, −3u],
y5 = y7;   y6 = y8;   top10y6 = h;   .5[y5, y6] = a,
draw 5..6;                                                       % left diagonal
draw 7..8.                                                      % right diagonal

"Nabla or backwards-difference operator";
call charbegin('162, 15, 0, 0, ph, 0, 0);
hpen;   rt0x2 = round(r − u);   lft1x1 = round u;   top0y2 = h,   top1y1 = h,
bot1y5 = −o;   y6 = y5;
x6 − x2 = x1 − x5,   lft1x5 = lft0x6,   x4 = x2,   x3 = x1;
vpen;   top8y1 = h;   y3 = y1,
w9 draw 1..3;                                                         % bar line
lpen#;   w9 draw 5. 4;                                  % erase excess at upper left
hpen;   w1 draw 5..4;                                                % left diagonal
rpen#,   w1 draw 6..2;   w9 draw 6 .2,                      % erase excess at right
hpen;   w0 draw 6..2;                                               % right diagonal
y7 = y1;   lft0x7 = lft1x1,
w0 draw 2. 7 .7 .6.                                   % sharpen upper left corner
```

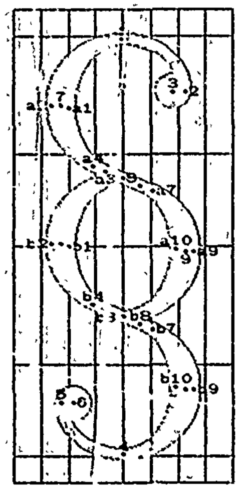


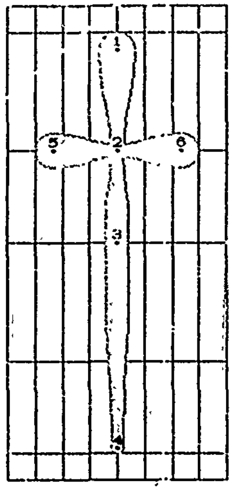


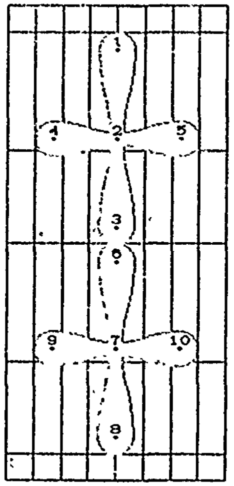
```
"Integral sign";
call charbegin('163, 9, 0, 0, ph, pd, 0);
hpen;  rt2x1 = rt0x2 = round(r - u);  y1 = y2;
lft2x9 = lft0x8 = round u;  y8 = y9;
cpen;  bot2y9 = -.9d;  y8 - y7 = y3 - y1;
hpen;  x3 = r - 2.5u;  x7 = 2 5u;
top0y3 = h;  bot0y7 = -d;
x5 = good1 .5r;  y5 = .5[y3, y7];
x4 = x5 + 5u;  y4 = y5 + .3(y3 - y7);
x6 = x5 - .5u;  y6 = y5 - .3(y3 - y7);
cpen;  w2 draw 1;                                                        % upper bulb
draw 9;                                                                  % lower bulb
hpen;  draw |w0|2{0, 1} . |w0#|3{-1, 0} . |.75[w0, w1]|4{x6 - x4, y6 - y4}
    |w1#|5 . |.75[w0, w1]|6{x6 - x4, y6 - y4}  |w0#|7{-1, 0}  8{0, 1}.      % stem

"Square set union sign (Scott lub)";
call charbegin('164, 13, 0, 0, ph, ph - 2pa, 0),
cpen,  lft10x1 = round u;  x2 = x1;  x4 = x5 = r - x1,
y1 = good10(.5[m, h]);  .5[y1, y2] = a;  y2 = y4,  y5 = y1,
w10 draw 1 .2..2. 4..4..5.                                               % stroke

"Square set intersection sign (Scott glb)";
call charbegin('165, 13, 0, 0, ph, ph - 2pa, 0);
cpen;  lft10x1 = round u;  x2 = x1;  x4 = x5 = r  x1;
y2 = good10(.5[m, h]);  .5[y1, y2] = a;  y2 = y4,  y5 = y1;
w10 draw 1..2..2..4..4..5.                                               % stroke

"Square reflexive subset sign";
call charbegin('166 18, 0, 0, ph, ph - 2pa, 0);
cpen;  lft10x6 = round 2.5u;  x2 = x3 = x7 = r - x6;  lft10x4 = x6;
top10y2 = h;  5[y2, y3] = y1;  y2 - y1 = (good10 5[m, h]) - (good10 a);
x4 = x5;  y4 = y2;  y5 = y3;
w10 draw 2..4..4..5..5..3;                                               % stroke
y6 = y7;  bot10y6 = 2a - h,
draw 6..7.                                                               % bar
```

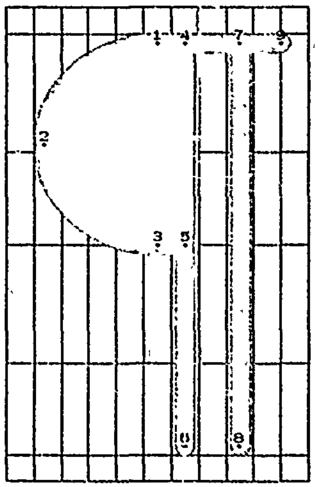




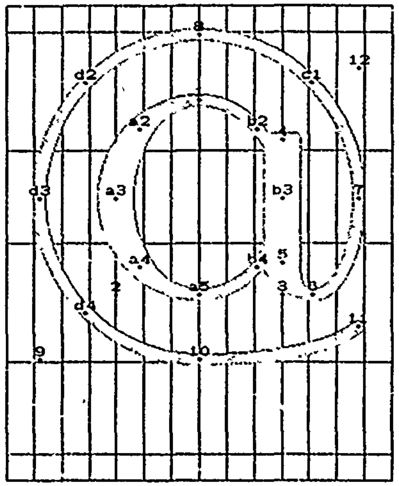


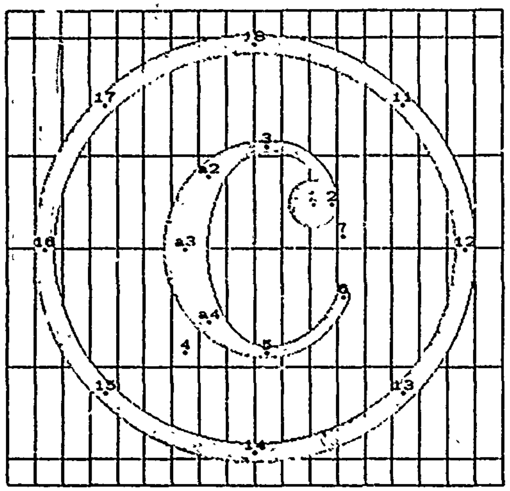




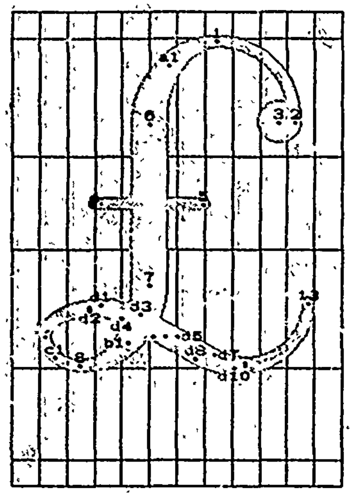


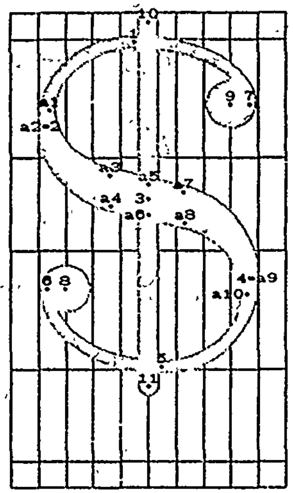
```
"Section sign";
call charbegin('170, 8, 0, 0, ph, pd, 0),
hpen;   x1 = x4 = .5r;   rt0x2 = rt1x3 = round(r − 1.5u),   lft0x5 = lft1x6 = round 1.5u;
top0y1 = h + oo;   bot0y4 = −d − oo;
y2 = y3 = .125[y4, y1];   y5 = y6 = .125[y1, y4];
w0 draw 1{1,0}. 2{0,−1},                                           % upper link
draw 4{−1,0}..5{0,1},                                              % lower link
cpen,   w1 draw 3;   draw 6,                                       % bulbs
x7 = x11 = x5,   x9 = x12 = x2;   x8 = x10 = x1;
y8 = ⅓[y4, y1];   y10 = ⅓[y1, y4];
call 'a sdraw(1, 7, 8, 9, 10, w1 − deltaw, w0, −(h + d)/(36u));    % upper stroke
call 'b sdraw(8, 11, 10, 12, 4, w1 − deltaw, w0, −(h + d)/(36u))   % lower stroke

"Dagger mark";
call charbegin('171, 8, 0, 0, ph, pd, 0),
cpen,   x1 = x2 = x3 = x4 = good1(.5r);   lft1x5 = round u,   x6 − x2 = x2 − x5;
top1y1 = h;   bot0y4 = −d,   y2 = y5 = y6 = good1m;   y3 = c,
w1 draw 1;   draw 5;   draw 6;                                     % bulbs
hpen;   draw |w1|1 . |w0|2;                                        % top stem
draw |w0|2  |(round 5[w0, w1]) − eps#|3 . |w0|4;                   % bottom stem
vpen;   draw |w1|5. |w0|2;   draw |w1|6  |w0|2.                    % bars

"Double dagger mark";
call charbegin('172, 8, 0, 0, ph, pd, 0);
cpen;   x1 = x2 = x3 = x6 = x7 = x8 = good1(.5r),   lft1x4 = round u,   x5 − x2 = x2 − x4;
x9 = x4;   x10 = x5;
top1y1 = h,   bot1y3 = .5[y1, y8] = top1y6,   bot1y8 = −d,
y2 = y4 = y5 = good1 .5[y1, y3],   y7 = y9 = y10 = good1 .5[y6, y8];
w1 draw 1;   draw 3,   draw 4,   draw 5;   draw 6;   draw 8;   draw 9;   draw 10,% bulbs
hpen;   draw |w1|1..|w0|2;   draw |w1|3 . |w0|2;
     draw |w1|6. |w0|7;   draw |w1|8..|w0|7;                       % stems
vpen;   draw |w1|4..|w0|2;   draw |w1|5  |w0|2;
     draw |w1|9. |w0|7;   draw |w1|10  |w0|7                       % bars

"Paragraph mark";
call charbegin('173, 11, 0, 0, ph, pd, 0);
cpen;   top10y1 = h;   bot10y6 = −d;   y4 = y7 = y9 = y1;
y8 = y6,   y3 = y5 = good10 .5[y1, y6];
lft10x2 = round u,   y2 = .5[y1, y3],   x1 = x3 = .5r,   x4 = x5 = x6 = good10 .5(r + 2u),
x7 = x8 = x6 + 2u;   x9 = r − u,
w10 ddraw 4..1{−1,0}..2{0,−1}  3{1,0}. 5,4 .4    5. 5,          % filled bowl
draw 6..4. 1  9;                                                % left stem and upper serif
draw 7..8.                                                      % right stem
```



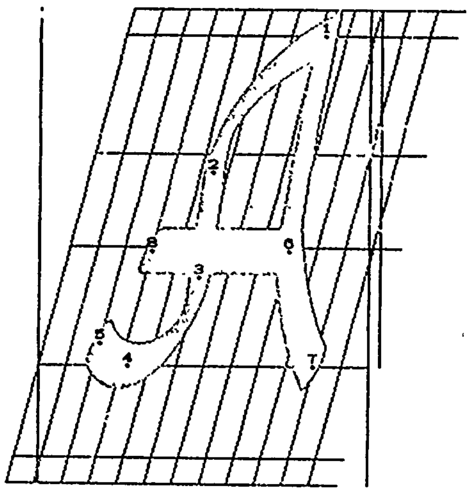


```
"At sign";
call charbegin('174, 14, 0, 0, ph, 0, 0);
hpen;   x1 = x8 = x10 = .5r,   x2 = good1 4u;   x3 = x4 = x5 = r − x2,
lft0x9 = round u;   x7 = x11 = x12 = r − x9;   x6 = 5/12[x5, x7];
top0y8 = h + oo;   bot0y10 = −oo;   y9 = y10;
y1 = good6 .8[y10, y8];   y2 = y3 = y6 = good6 .2[y10, y8];
y7 = .5[y10, y8];   y11 = good6 .1[y10, y8];   y12 = .9[y10, y8];
y4 = .8[y2, y1];   y5 = 2/3[y7, y6];
call `a darc(1, 2, w1);                                          % left part of inner bowl
call `b darc(1, 3, w0);                                          % right part of inner bowl
draw |w1|4..|w1#|5{0, −1}: |w0#|6{1, 0}..7{0, 1};                        % stem and link
call `c arc(8, 7, w0);                                           % right part of outer bowl
call `d darc(8, 9, w0);                                          % left part of outer bowl
w0 draw 10{1, 0}..11(..12).                                                     % point

"Copyright symbol";
call charbegin('175, 18, 0, 0, ph, pd, 0);
new up;   up = .5((h − m) − d);                  % amount to raise baseline of lowercase c
cpen;   rt3x1 = round(r − 6u);
if top3(top3top6e + 2) > .9[e, m]:   top3y1 = .9[e, m] + up;
else:   y1 = top3top6e + 2 + up;
fi;
w3 draw 1,                                                                       % bulb
hpen;   rt0x2 = rt3x1;   y2 = y1;   x4 = x5 = .5(r + u);   top0y4 = m + oo + up;
w0 draw 2{0, 1}..3{−1, 0};                                                   % shoulder
if w2 > 1.5u:   lft2x1 = round(5.75u);
else:   x1 = good2 6.5u;
fi;
y4 = y5;   bot0y5 = −oo + up;
call `a darc(3, 4, w2);                                                        % stroke
if w0 = w1:   x6 = x2;   x7 − x5 = x5 − x1;   y7 = .5[y3, y5];
     new aa;   x6 = aa[x5, x7];   y6 = (sqrt(1 − aa aa))[y7, y5];
else   lft0x6 = rt0x2;   y6 = .5e − 1 + up;   x7 = x6;   y7 = e + up;
fi;
w0 draw 5{1, 0}..6(..7);                                                        % point
cpen;   top10y18 = h + oo;   bot10y14 = −d − oo;
lft10x16 = round u;   rt10x12 = round(r − u);
call circle(11, 12, 13, 14, 15, 16, 17, 18, w10).                      % enclosing cirle
```





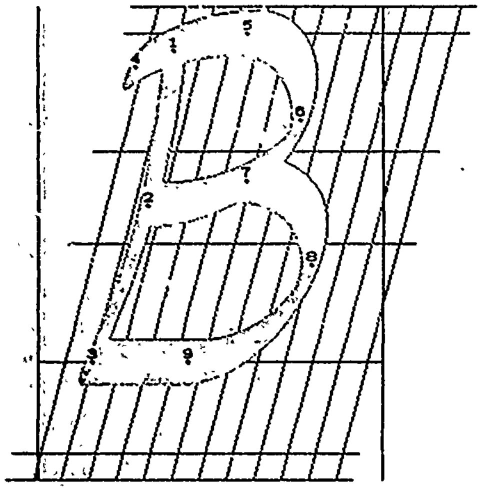
```
"Sterling sign";
call charbegin('176, 12, 0, 0, ph, 0, 0);
hpen;   x1 = 7.5u;   top0y1 = h + oo;   rt0x2 = rt0x3 = round(r − 1.5u);
y2 = y3 = .75h;   y4 = y5 = .5h;   x4 = 3u − eps;   x5 = 7u + eps;
x6 = x7 = good1 5u;   y6 = .75[y8, y1];   y7 = .25[y8, y1];   bot0y8 = −oo;
x8 = 2.5u;   lft0x9 = round u;   y9 = .1h;
w0 draw 1{1, 0} .. 2{0, −1};                                           % link
cpen;   w2 draw 3;                                                    % bulb
call `a arc(1, 6, w1);                                            % shoulder
hpen;   w1 draw 6 .. 7;                                               % stem
w0 draw 4 .. 5;                                                        % bar
call `b arc(8, 7, w1);   call `c arc(8, 9, w0);                        % loop
top11y10 = round .2h;   bot11y12 = −oo;
x11 = .5[x8, x13] − u;   y11 = y9;
rt0x13 = round(r − u);   y13 = .2h;
call `d zdraw(9,    11, 12, 13, w11, w7, −(x11 − x8 − 4u)/( 2h)).      % arm

"Dollar sign";
call charbegin('177, 10, 0, 0, ph + pb, pb, ph·slant − 5pu);
hpen;   top0y1 = h + oo;   bot0y5 = −oo;
x3 = good10 .5r;   y3 = .52h;   lft11x2 = round u;   x4 = r − x2;
if ucs = 0:   x1 = x5 = x3;   y6 = .5[y5, y3];   y7 = .5[y1, y3];
else:   if w6 = w9:   x1 = x5 = x3,   y6 = .5[y5, y3],   y7 = 5[y1, y3];
     else:   x1 + .5u = x5 − .5u = x3;   y6 = h/4 − 1;   y7 = 8h + 1;
     fi;
fi,
y8 = y6;   y9 = y7;   cpen;   lft3x8 = lft0x6;   rt3x9 = rt0x7;   x6 = x2;   x7 = x4;
w3 draw 8;                                                      % lower bulb
draw 9;                                                         % upper bulb
hpen;   w4 draw 6{0, −1} .. 5{1, 0};                      % lower left stroke
draw 7{0, 1} .. 1{−1, 0},                                % upper right stroke
call `a sdraw(1, 2, 3, 4, 5, w11, w9, − h/(50u));            % middle stroke
cpen;   x10 = x11 = x3;   top10y10 = h + b;   bot10y11 = −b,
w10 draw 10 .. 11.                                                    % stem
```

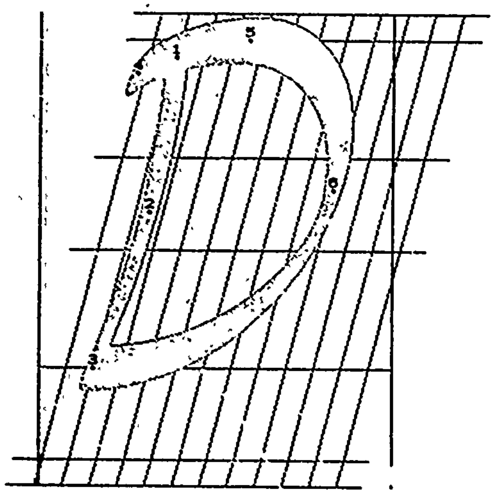


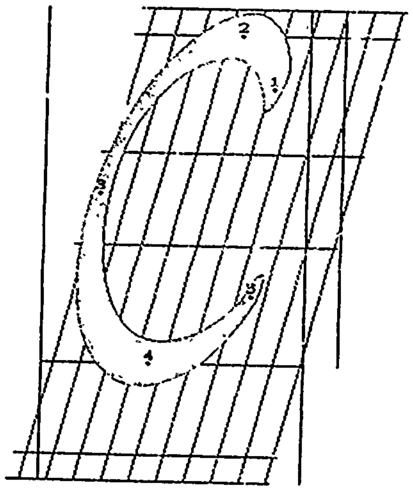
```
i.put symext;                          % possible characters '067, '077, '156, '157, '167
```

The file script.mf

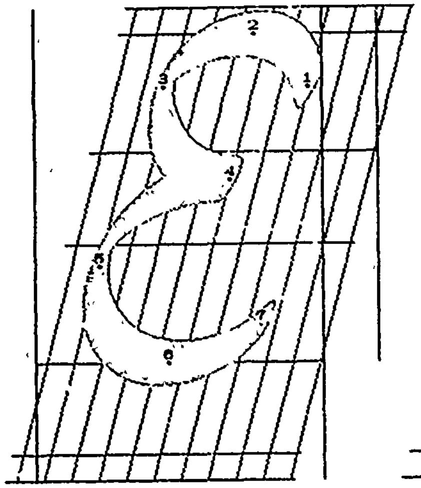
```
% This script alphabet is based on traditional Chancery style, except
% that descenders are eliminated, and the letters I, J, Q, T have been
% modified to accord with modern practice suitable for use with
% mathematics. All the letters are drawn with a single pen, whose
% dimensions are pw by pwv, rotated to the angle whose tangent is 2.
new aa, bb. aaa, bbb, spa, spb, spc;                     % variables to specify the spen
aa = (sqrt 1.25)(pwv·pixels + blacker);
bb = (sqrt 1.25)(pw·pixels + blacker);
aaa = 1/aa/aa;   bbb = 1/bb/bb;
spen(aaa + 4bbb, 4aaa - 4bbb, 4aaa + bbb, 0, 0, 0, 0);
no penreset;
new cor, corr;                                   % commonly used spacing correction*
cor = ph·slant/pu;
if cor > 1:   corr = 1;
else:   corr = cor;
fi;

"Script A";   spen;
call charbegin('A, 12, 0, 0, ph, 0, ph·slant - (3 75 - mi)pu);
x1 = 7.25u;   y1 = h;
x2 = 4.5u;   y2 = .59h;
x3 = 5u;   y3 = .27h;
x4 = 3 25u;   y4 = 0;
x5 = 2u;   y5 = .07h;
x6 = 8u;   y6 = .35h;
x7 = 10u;   y7 = 0;
x8 = 3u;   y8 = .35h;
draw 1{3(x2 - x1), y2 - y1}..2{x3 - x2, y3 - y2}..3{x4 - x3, y4 - y3}..
     4{-1, 0}..5{x5 - x4, 3(y5 - y4)};                              % left diagonal
draw 1{0, 1}..6{x7 - x6, 1.5(y7 - y6)}..7{1.5(x7 - x6), y7 - y6};    % right diagonal
draw 8..6.                                                           % bar
```

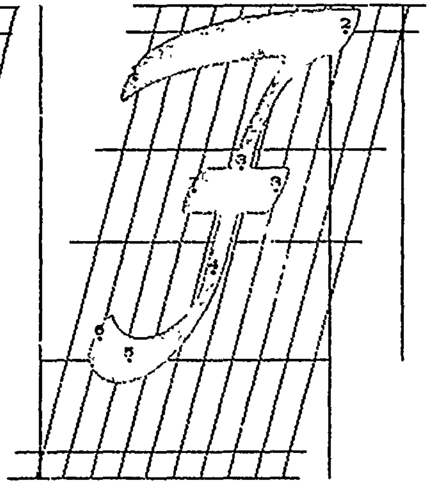


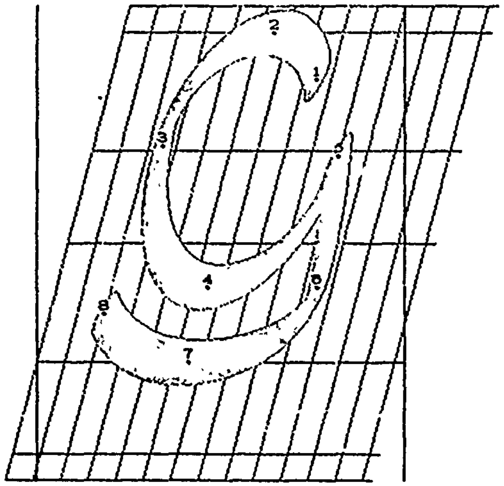




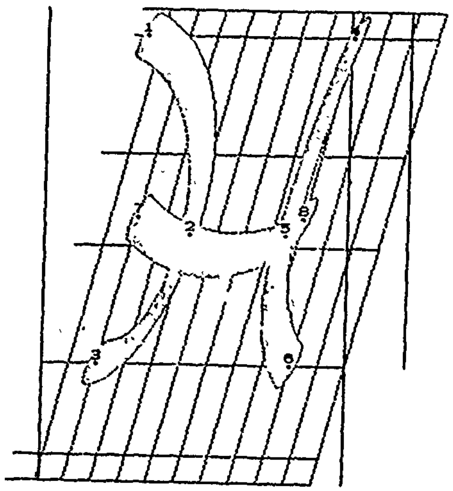
```
"Script B";   spen;
call charbegin(`B, 12, mi·corr, —.5mi·cor, ph, 0, mi[.5ph slant — pu, 0]);
x1 = 3u;   y1 = .95h;
x2 = 3.5u;   y2 = .48h;
x3 = 3u;   y3 = 0;
x4 = 1.75u;   y4 = .9h;
x5 = 5.5u;   y5 = h;
x6 = 8.25u;   y6 = .74h;
x7 = (sqrt .5)[x2, x6];   y7 = (sqrt .5)[y6, y2];
x8 = 10u;   y8 = .3h;
x9 = 6.5u;   y9 = 0;
draw 1{2(x2 — x1), y2 — y1}..2{0, —1}..3{2(x3 — x2), y3 — y2};              % stem
draw 4{x5 — x4, 3(y5 — y4)}..5{1, 0}..6{0, —1}..
     7{x2 — x6, y2 — y6}..2{—1, 0};                                    % upper bowl
draw 7{1, 0}..8{0, —1}..9{—1, 0}..3.                                   % lower bowl

"Script C";   spen;
call charbegin(`C, 10.5, .5mi·cor, —.2mi·cor, ph, 0,
                 mi[ph·slant — 2.25pu, .8ph·slant — 1.25pu]);
x1 = 7.25u;   y1 = .84h;
x2 = 5.5u;   y2 = h;
x3 = 2u;   y3 = .52h;
x4 = 5.5u;   y4 = 0;
x5 = 8.5u;   y5 = .21h;
draw 1{x2 — x1, 4(y2 — y1)}..2{—1, 0}..3{0, —1}..4{1, 0}..
     5{x5 — x4, 4(y5 — y4)}.                                           % bowl

"Script D";   spen;
call charbegin(`D, 12, mi·corr, —.6mi·cor, ph, 0, mi[.6ph·slant — pu, 0]);
x1 = 3u;   y1 = .95h;
x2 = 3.5u;   y2 = .48h;
x3 = 3u;   y3 = 0;
x4 = 1.75u;   y4 = .9h;
x5 = 5.5u;   y5 = h;
x6 = 10u;   y6 = .55h;
draw 1{2(x2 — x1), y2 — y1}..2{0, —1}..3{2(x3 — x2), y3 — y2};              % stem
draw 4{x5 — x4, 3(y5 — y4)}..5{1, 0}..6{0, —1}..3{—1, 0}.                  % bowl
```

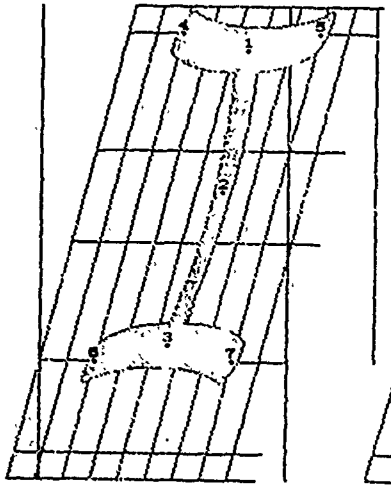


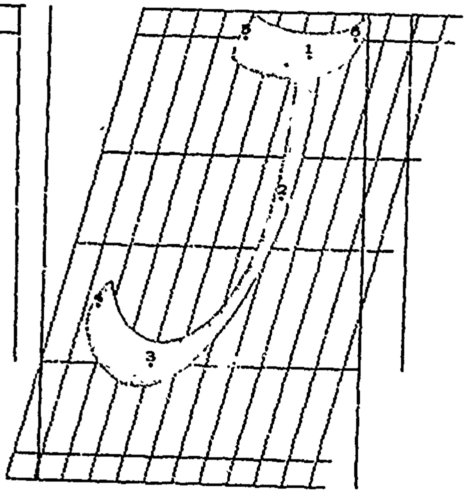




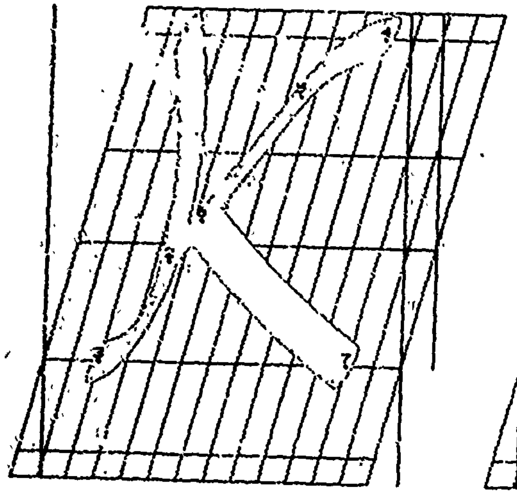
```
"Script E";   spen;
call charbegin(`E, 10.5, .2mi·cor, —.2mi·cor, ph, 0, mi[ph·slant — 1.5pu, .8ph·slant — .5pu]);
x1 = 8u;   y1 = .84h;
x2 = 5.5u;   y2 = h;
x3 = 2.75u;   y3 = .84h;
x4 = 6u;   y4 = .56h;
x5 = 2u;   y5 = .3h;
x6 = 5.5u;   y6 = 0;
x7 = 8.5u;   y7 = .12h;
draw 1{x2 — x1, 4(y2 — y1)}..2{—1, 0}..3{0, —1}..4{1, 0};                % upper bowl
draw 4{—1, 0}..5{0, —1}..6{1, 0}..7{x7 — x6, 3(y7 — y6)}.                % lower bowl

"Script F";   spen;
call charbegin(`F, 11, mi·corr, mi(1 — .5cor), ph, 0, mi[ph·slant — pu, .5ph·slant + pu]);
x1 = 1.75u;   y1 = .86h;
x2 = 9u;   y2 = h;
x3 = 6.5u;   y3 = .59h;
x4 = 6.5u;   y4 = .27h;
x5 = 4.25u;   y5 = 0;
x6 = 3u;   y6 = .07h;
x7 = 5u;   y7 = .52h;
x8 = 8u;   y8 = .52h;
draw 1{x2 — x1, 5(y2 — y1)}..2{1, 0};                                      % shoulder
draw 2{—1, 0}..3{0, —1}..4{0, —1}..5{—1, 0}..6{x6 — x5, 3(y6 — y5)};          % stem
draw 7..8.                                                                    % bar

"Script G";   spen;
call charbegin(`G, 11.5, 0, mi(—.75cor + .5corr), ph, 0, mi[.75ph·slant — 1.5pu, 0]);
x1 = 7.5u;   y1 = .86h;
x2 = 5.5u;   y2 = h;
x3 = 2.5u;   y3 = .66h;
x4 = 5.5u;   y4 = .23h;
x5 = 9u;   y5 = .63h;
x6 = 9.5u;   y6 = .23h;
x7 = 5.5u;   y7 = 0;
x8 = 2u;   y8 = .15h;
draw 1{x2 — x1, 4(y2 — y1)}..2{—1, 0}..3{0, —1}.;4{1, 0}..5{0, 1};        % upper bowl
draw 5{2(x6 — x5), y6 — y5}..6{0, —1}..7{—1, 0}..8{x8 — x7, 3(y8 — y7)}.       % taii
```

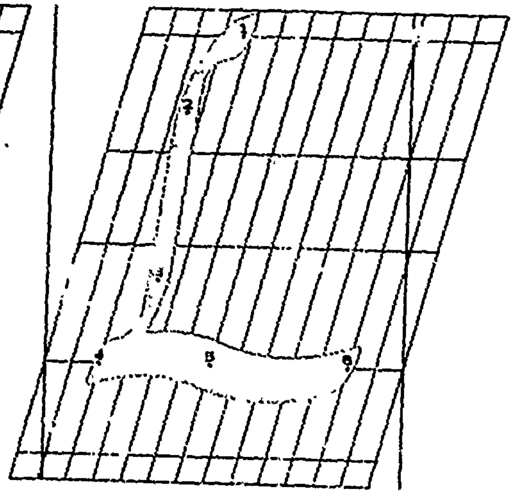


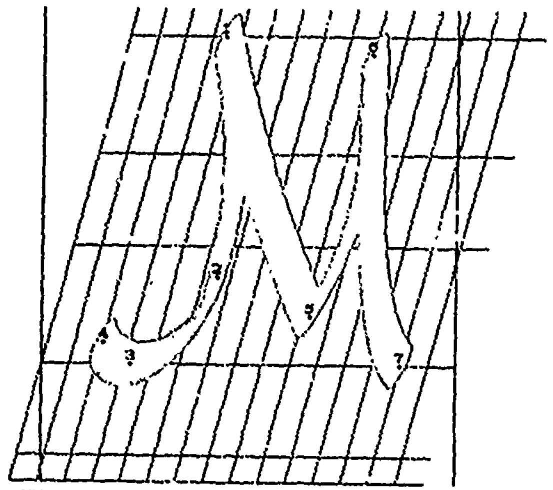




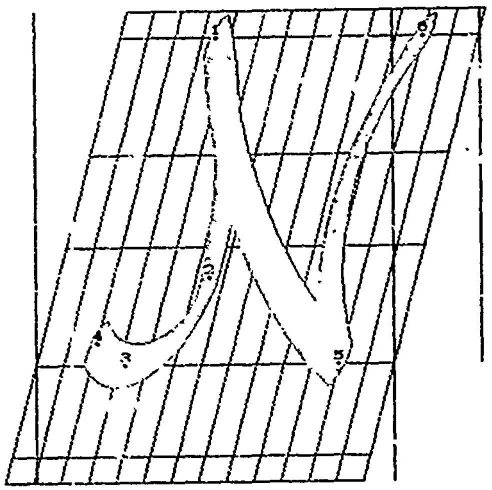
```
"Script H";   spen;
call charbegin(`H, 12, mi·corr, 0, ph, 0, ph·slant − (2 − mi)pu);
x1 = 1.5u;   y1 = h;
x2 = 5u;   y2 = .4h;
x3 = 3u;   y3 = 0;
x4 = 9u;   y4 = h;
x5 = 8.5u;   y5 = .4h;
x6 = 10u;   y6 = 0;
x7 = 3u;   y7 = .45h;
x8 = 9u;   y8 = .45h;
draw 1{5(x2 − x1), y2 − y1}..2{0, −1}..3{−1, 0};                      % left stem
draw 4{2(x5 − x4), y5 − y4}..5{0, −1}..6{3(x6 − x5), y6 − y5};       % right stem
draw 7{7u − x7, .15h − y7}..8{x8 − 7u, y8 − .15h}.                          % bar

"Script I";   spen;
call charbegin(`I, 9, 0, 0, ph, 0, ph·slant − (1 − mi)pu);
x1 = 4.5u;   y1 = .95h;
x2 = 5u;   y2 = .52h;
x3 = 4.5u;   y3 = .05h;
x4 = 2u;   y4 = h;
x5 = 7u;   y5 = h;
x6 = 2u;   y6 = 0;
x7 = 7u;   y7 = 0;
draw 1{2(x2 − x1), y2 − y1}..2{0, −1}..3{2(x3 − x2), y3 − y2};          % stem
draw 4{x1 − x4, 3(y1 − y4)}..1{1, 0}..5{x5 − x1, 3(y5 − y1)};       % upper serif
draw 6{x3 − x6, 3(y3 − y6)}..3{1, 0}..7{x7 − x3, 3(y7 − y3)}.       % lower serif

"Script J";   spen;
call charbegin(`J, 10, 0, −.5mi·cor, ph, 0, mi[ph·slant − pu, .5ph·slant]);
x1 = 6.5u;   y1 = .95h;
x2 = 7u;   y2 = .52h;
x3 = 4u;   y3 = 0;
x4 = 1.5u;   y4 = .18h;
x5 = 4u;   y5 = h;
x6 = 8u;   y6 = h;
draw 1{2(x2 − x1), y2 − y1}..2{0, −1}..
     3{−1, 0}..4{x4 − x3, 3(y4 − y3)};                                 % stem and tail
draw 5{x1 − x5, 3(y1 − y5)}..1{1, 0}..6{x6 − x1, 3(y6 − y1)}.               % serif
```

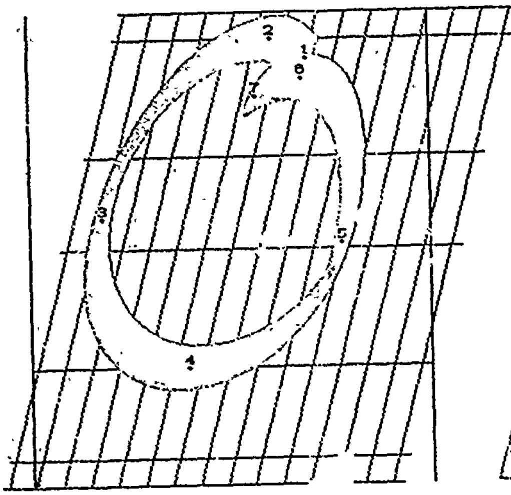


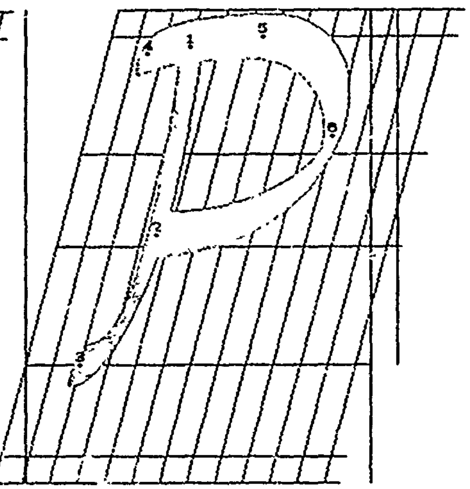




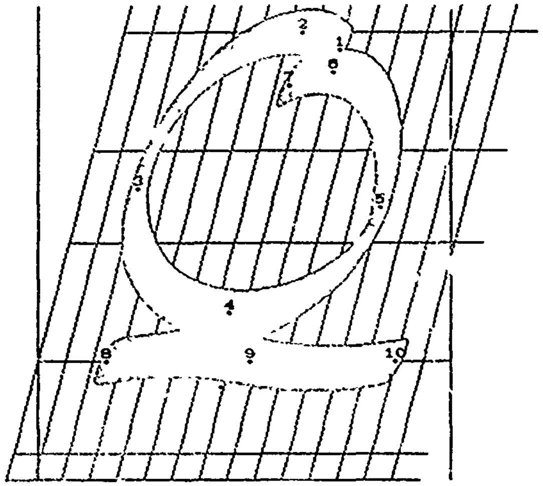
```
"Script K";   spen;
call charbegin(`K, 13, 0, 0, ph, 0, ph·slant — (3 — mi)pu);
x1 = 1.75u;   y1 = h;
x2 = 3.5u;   y2 = .31h;
x3 = 2u;   y3 = 0;
x4 = 9u;   y4 = h;
x5 = 6.5u;   y5 = .82h;
x6 = 4.25u,   new aa;   x6 = aa[x2, x5];   y6 = aa[y2, y5];
x7 = 11u,   y7 = 0;
draw 1{2(x2 — x1), y2 — y1} . . 2{0, —1} . . 3{—1, 0};                       % stem
draw 4{—1, 0} . . 5{x2 — x5, y2 — y5} . . 2;                       % upper diagonal
draw 6{x7 — x6, 1.25(y7 — y6)} . . 7{1.25(x7 — x6), y7 — y6}.                % lower diagonal

"Script L";   spen;
call charbegin(`L, 13, 0, 0, ph, 0, 0);
x1 = 3.75u;   y1 = h;
x2 = 2.5u;   y2 = .77h;
x3 = 3.25u;   y3 = .26h;
x4 = 2u;   y4 = 0;
x5 = 6u;   y5 = 0;
x6 = 11u;   y6 = 0;
draw 1{—1, 0} . . 2{x3 — x2, y1 — y2} . . 3{x3 — x2, y3 — y2} . . 4{—60u, —h};        % stem
draw 4{30u, h} . . 5{30u, —h} . . 6{30u, h}.                                 % bar

"Script M";   spen;
call charbegin(`M, 15, 0, 0, ph, 0, 0);
x1 = 3.5u;   y1 = h;
x2 = 5.5u;   y2 = .27h;
x3 = 3.25u;   y3 = 0;
x4 = 2u;   y4 = .07h;
x5 = 9.25u;   y5 = .15h;
x6 = 9u;   y6 = .95h;
x7 = 13u,   y7 = 0;
draw 1{2(x2 — x1), y2 — y1} . . 2{0, —1} . .
      3{—1, 0} . . 4{x4 — x3, 3(y4 — y3)};                             % first diagonal
draw 1{x5 — x1, 1.25(y5 — y1)} . . 5{1.25(x5 — x1), y5 — y1};           % second diagonal
draw 5{4u, h} . . 6{—4u, h};                                          % third diagonal
draw 6{x7 — x6, 1.5(y7 — y6)} . . 7{3(x7 — x6), y7 — y6}.             % fourth diagonal
```

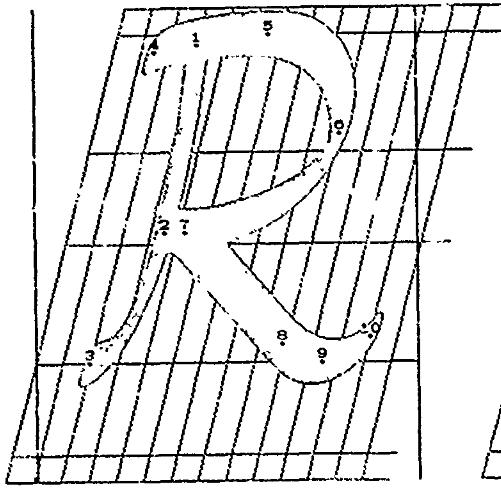


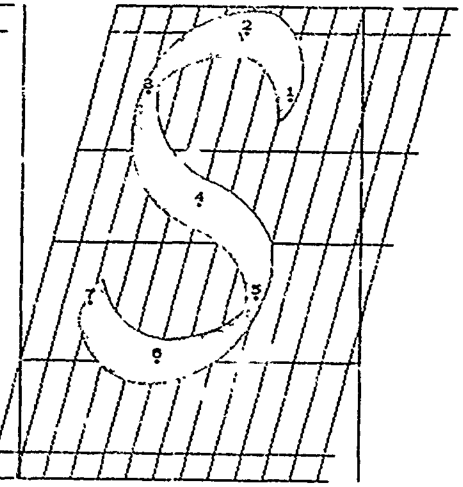




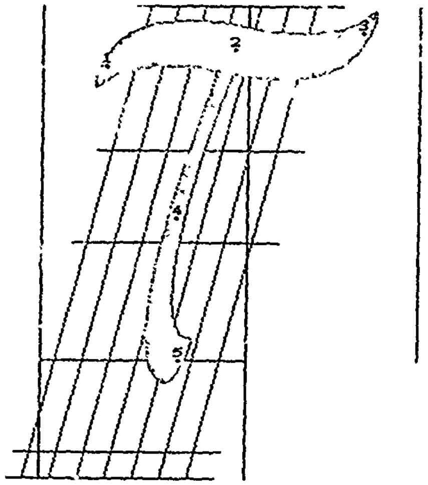
```
"Script N";   spen;
call charbegin(`N, 13, 0, 0, ph, 0, ph·slant — (1 — mi)pu);
x1 = 3.5u;   y1 = h;
x2 = 5.5u;   y2 = .27h;
x3 = 3.25u;   y3 = 0;
x4 = 2u;   y4 = .07h;
x5 = 11u;   y5 = 0;
x6 = 11u;   y6 = h;
draw 1{2(x2 — x1), y2 — y1}..2{0, —1}..3{—1, 0}..4{x1 — x3, 3(y1 — y3)};      % left stem
draw 1{x5 — x1, 2(y5 — y1)}..5{2(x5 — x1), y5 — y1};                             % diagonal
draw 5{—6u, h}..6{6u, h}.                                                     % right stem

"Script O";   spen;
call charbegin(`O, 13, .25mi·cor, —.75mi·cor, ph, 0, mi[.75ph slant — pu, 0]);
x1 = 8u;   y1 = .94h;
x2 = 6.5u;   y2 = h;
x3 = 2u;   y3 = .46h;
x4 = 6.5u;   y4 = 0;
x5 = 11u;   y5 = .38h;
x6 = 8u;   y6 = .88h;
x7 = 6.5u;   y7 = .83h;
draw 1{x2 — x1, 2(y2 — y1)}..2{—1, 0}..3{0, —1}..4{1, 0}..5{0, 1}..
     6{—1, 0}..7{x7 — x6, 4(y7 — y6)}.                                       % bowl

"Script P";   spen;
call charbegin(`P, 11, 0, —.5mi·cor, ph, 0, mi[.8ph slant — pu, 3ph·slant]);
x1 = 3u;   y1 = .97h;
x2 = 3.5u;   y2 = .4h;
x3 = 2u;   y3 = 0;
x4 = 1.5u;   y4 = .95h;
x5 = 5.5u;   y5 = h;
x6 = 9u;   y6 = .7h;
draw 1{2(x2 — x1), y2 — y1}..2{0, —1}..3{—1, 0};                                  % stem
draw 4{x5 — x4, 4(y5 — y4)}..5{1, 0}..6{0, —1}..2{—1, 0}.                         % bowl
```

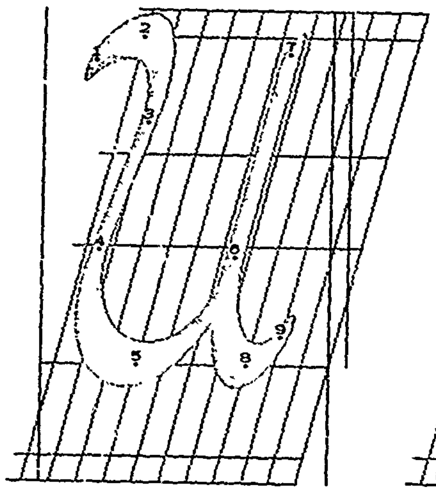


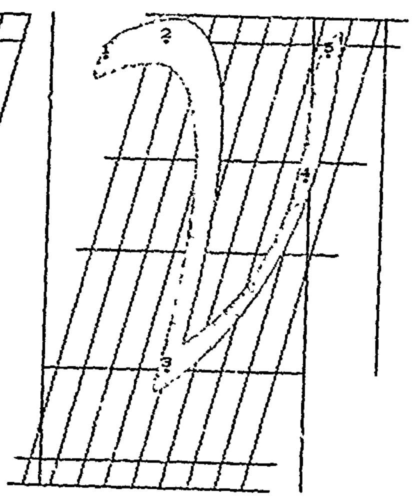




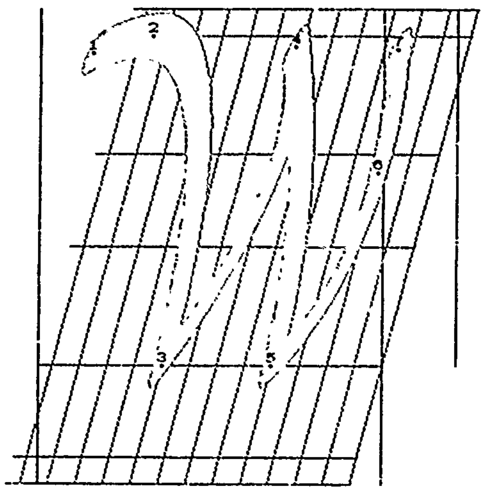
```
"Script Q";   spen;
call charbegin('Q, 15, 0, 0, ph, 0, 0);
x1 = 8u;   y1 = .95h;
x2 = 6.5u;   y2 = h;
x3 = 2u;   y3 = .53h;
x4 = 6.5u;   y4 = .15h;
x5 = 11u,   y5 = .47h;
x6 = 8u;   y6 = .88h;
x7 = 6 5u;   y7 = .84h;
x8 = 2.5u;   y8 = 0;
x9 = 7.75u;   y9 = 0;
x10 = 13u;   y10 = 0,
draw 1{x2 -- x1, 2(y2 - y1)} .. 2{-1, 0} .. 3{0, -1} .. 4{1, 0} .. 5{0, 1} ..
     6{-1, 0} .. 7{x7 - x6, 4(y7 - y6)};                                   % bowl
draw 5{0, -1} .. 8{ -120u, -h};                                            % link
draw 8{60u, h} .. 9{60u, -h} .. 10{60u, h}.                                % bar

"Script R";   spen;
call charbegin('R, 14, 0, 0, ph, 0, 0);
x1 = 3u;   y1 = .97h;
x2 = 3.5u;   y2 = .4h;
x3 = 2u;   y3 = 0;
x4 = 1.5u;   y4 = .95h,
x5 = 5.5u   y5 = h;
x6 = 9u;   y6 = 7h;
x7 = 4.25u;   y7 = .4h;
y8 = .06h;                                                   % x8 will be defined shortly
x9 = 10.5u;   y9 = 0;
(x9 - x8)/(y9 - y8) = 2(x8 - x7)/(y8 - y7);
x10 = 12u;   y10 = 08h;
draw 1{2(x2 -- x1), y2 - y1} . 2{0, -1}  .3{ -1, 0},                      % stem
draw 4{x5 - x4, 4(y5 - y4)} .. 5{1, 0}   6{0, -1}   2{-1, 0};             % bowl
draw 7 .. 8{x8 -- x7, y8 - y7} .. 9{1, 0} .. 10{x10 - x9, 3(y10 - y9)}.   % diagonal

"Script S";   spen;
call charbegin('S, 10, 0, -mi(cor -  75corr), ph, 0, mi[ph slant - 1 75pu, 0]);
x1 = 7.25u;   y1 = .8h;
x2 = 5u;   y2 = h;
x3 = 2u;   y3 =  82h,
x4 = 5u;   y4 = .48h;
x5 = 8u;   y5 = .2h;
x6 = 5u;   y6 = 0;
x7 = 2u;   y7 = .18h;
draw 1{x2 - x1, 4(y2 - y1)} . 2{-1, 0}   3{0, -1} . 4{32u,   h} . 5{0, -1}
     6{-1, 0} .. 7{x7 - x6, 3(y7 - y6)}.                                   % stroke
```

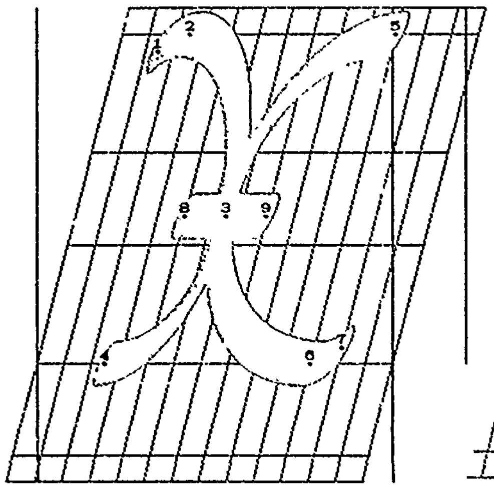


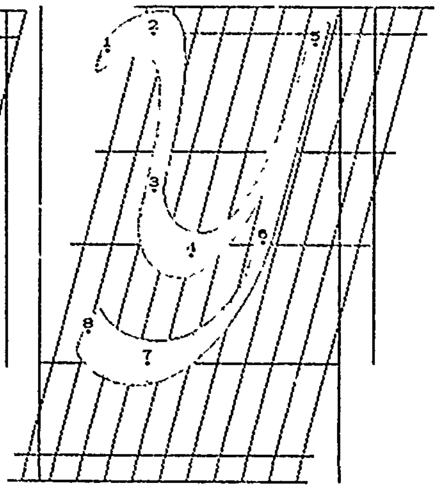




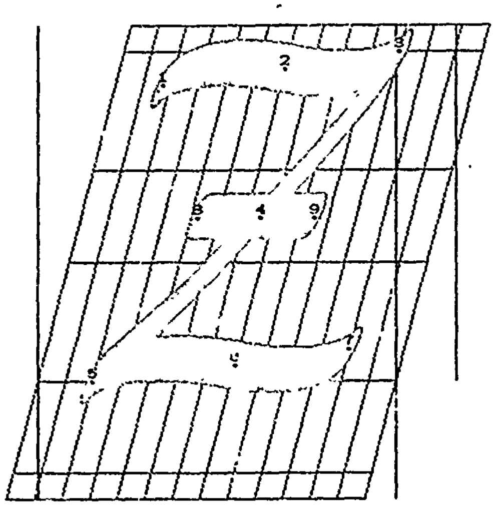
```
"Script T";   spen;
call charbegin(`T, 13, .8mi·cor, 3mi, ph, 0, ph slant + (4mi − 1)pu);
x1 = 2u;   y1 = .9h;
x2 = 6.5u,   y2 = .95h;
x3 = 11u;   y3 = h;
x4 = 6u;   y4 = .44h;
x5 = 7.5u;   y5 = 0;
draw 1{6u,h}..2{60u,−h}..3{6u,h};                                    % bar
draw 2{2(x1 − x2), y1 − y2}..4{0,−1}..5{1,0}.                        % stem

"Script U";   spen;
call charbegin(`U, 13, .8mi·cor, 0, ph, 0, ph·slant − (3.5 − mi)pu);
x1 = 1.5u;   y1 = .93h;
x2 = 3u;   y2 = h;
x3 = 4u;   y3 = .74h;
x4 = 3.5u;   y4 = .35h;
x5 = 6u;   y5 = 0;
x6 = 8.5u;   y6 = .33h;
x7 = 8.5u;   y7 = .95h;
x8 = 10u;   y8 = 0;
x9 = 11u;   y9 = .09h;
draw 1{x2 − x1, 3(y2 − y1)}..2{1,0}..3{x4 − x3, y4 − y3}..4{x4 − x3, y4 − y3}..
     5{1,0}..6{0,1}..7;                                              % stroke and stem
draw 6{0,−1}..8{1,0}..9{x9 − x8, 4(y9 − y8)}.                         % point

"Script V";   spen;
call charbegin(`V, 12, .8mi·cor, 0, ph, 0, ph·slant − (1.5 − mi)pu);
x1 = 1.5u;   y1 = .95h;
x2 = 3.5u;   y2 = h;
x3 = 7u;   y3 = 0;
x4 = 10u;   y4 = .59h;
x5 = 9.5u;   y5 = .97h;
draw 1{x2 − x1, 2(y2 − y1)}..2{1,0}..3{0,−1};                         % left diagonal
draw 3{3(x4 − x3), y4 − y3}..4{0,1}..5{2(x5 − x4), y5 − y4}.          % right diagonal
```







```
"Script W";   spen;
call charbegin(`W, 15, 8mi·cor, 0, ph, 0, oh slant — (1.5 — mi)pu),
x1 = 1.5u;   y1 = .95h;
x2 = 3.5u;   y2 = h;
x3 = 7u,   y3 = 0;
x4 = 8 75u;   y4 = .97h;
x5 = 11u;   y5 = 0;
x6 = 13u;   y6 = .59h;
x7 = 12.5u;   y7 = .96h;
draw 1{x2 — x1, 2(y2 — y1)}   2{1, 0} . . 3{0, —1};                    % first diagonal
draw 3{x7 — x3, y7 — y3}   4{2(x4 — x5), y4 — y5};                    % second diagonal
draw 4{2(x5 — x4), y5 — y4}   5{0, — 1},                               % third diagonal
draw 5{3(x6 — x5), y6 — y5} .  6{0, 1} . . 7{2(x7 — x6), y7 — y6}.      % fourth diagonal

"Script X"·   spen;
call charbegin(`X, 13, 0, 0, ph, 0, ph slant — (2 — 1 5mi)pu);
x1 = 1 5u;   y1 =  95h;
x2 = 2 5u;   y2 = h;
x3 = 5.5u;   y3 = .45h;
x4 = 2.5u;   y4 = 0;
x5 = 10u;   y5 = h;
x6 = 10u;   y6 = 0;
x7 = 11u;   y7 = .05h;
x8 = 4u;   y8 = .45h;
x9 = 7u;   y9 = .45h;
draw 1{x2 — x1, 3(y2 — y1)} . . 2{1, 0}  . 3{0, —1} .  4{—1, 0};         % left stroke
draw 5{—1, 0} .  3{0, —1} .  6{1, 0}   7{x7 — x6, 3(y7 — y6)};           % right stroke
draw 8 .  9.                                                           % bar

"Script Y";   spen;
call charbegin(`Y, 11.5, .8mi·cor, —.6mi cor, ph, 0, mi[ph slant — pu, 4ph slant]);
x1 = 2u;   y1 = .95h;
x2 = 3 5u;   y2 = h;
x3 = 5u;   y3 = .53h;
x4 = 7u;   y4 = .33h;
x5 = 9.5u;   y5 = .97h;
x6 = 9.5u;   y6 =  37h;
x7 = 6.5u;   y7 = 0;
x8 = 4u;   y8 = .1h;
draw 1{x2 — x1, 3(y2 — y1)} . . 2{1, 0}  . 3{0, —1} . . 4{1, 0}   5{0, 1},   % stroke
draw 5 . . 6{0, —1} .  7{—1, 0} .  8{x8 — x7, 3(y8 — y7)}.                 % stem and tail
```



```
'Script Z";   spen;
call charbegin(`Z, 13, 0, 0, ph, 0, ph·slant — (2 — mı)pɔ);
x1 == 1.75u;   y1 = .9h;
x2 = 6u;   y2 = .95h;
x3 == 10u;   y3 = h;
x1 = 6 5u;   y1 == .5h,
x5 = 2u;   y5 == 0;
x6 = 7u;   y6 = .05h;
x7 = 11u;   y7 =  1h;
x8 =: 4 25u;   y8 = .5h;
x9 = 8.5u;   y9 = .5h;
draw 1{6u,h}..2{60u,—h}. 3{6u,h},                                        % upper bar
draw 3{x1 — x3, 2(y1 — y1)}..4{x5 — x3, y5 — y3}. 5{x5 — x1, 2(y5 — y1)};    % diagonal
draw 5{6u,h}..6{60u,—h} .7{6u,h},                                        % lower bar
draw 8..9.                                                               % middle bar
```

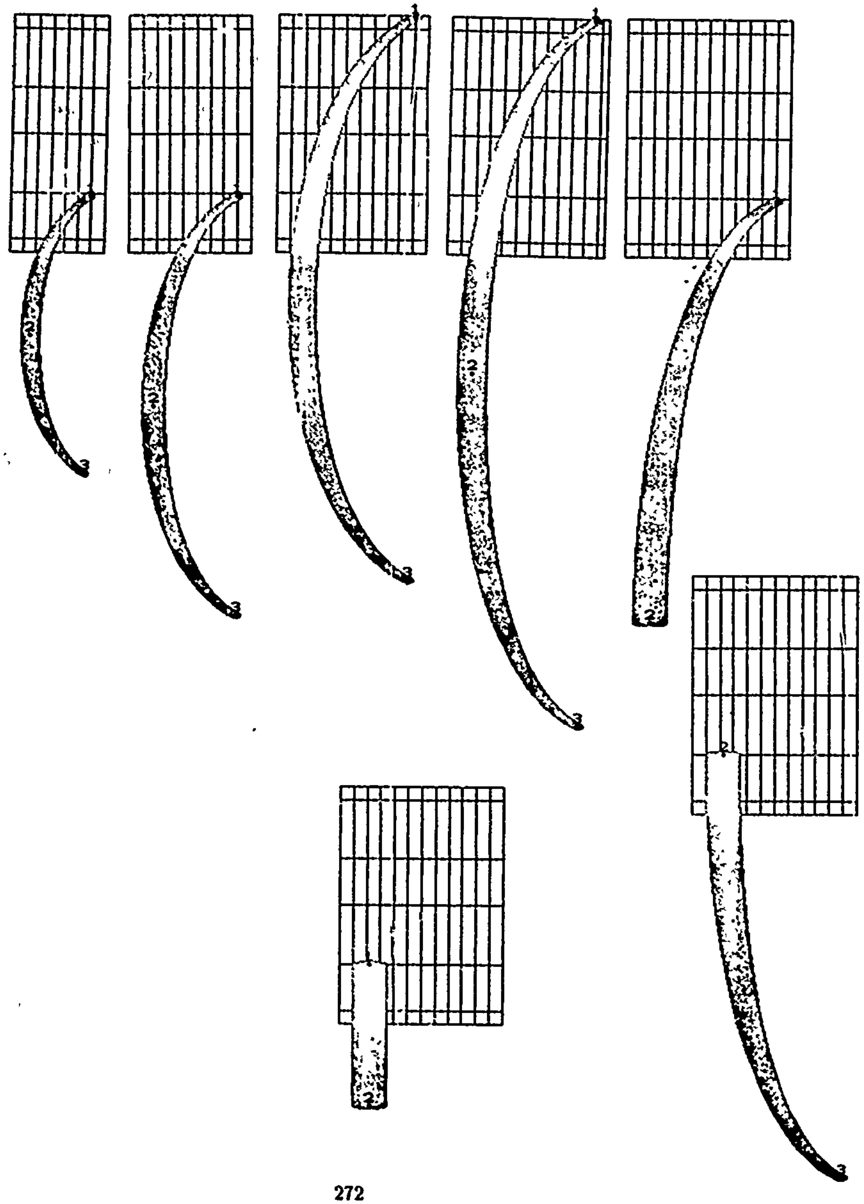
MATHEX CHARACTER DESIGNS

The file mathex.mf

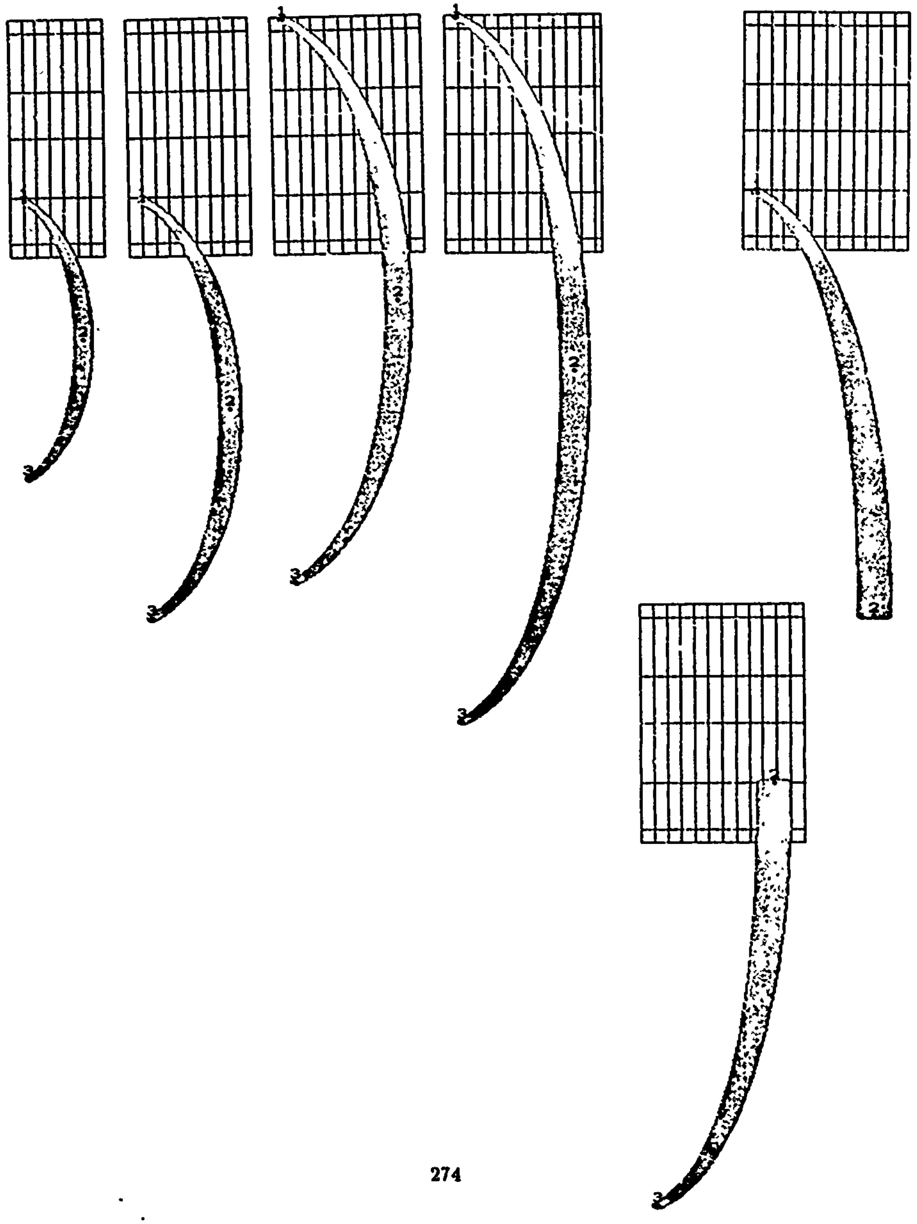
```
% The Computer Modern Math-Extension family of fonts (by D. E Knuth, 1979).
danger = 0;
new pt;                                                     % one virtual point
pt = typesize/10;                              % assumes 10 point specifications
% The following subroutines break up the large characters on an Alphatype CRS,
% assuming that 10pt equals 10 points.
subroutine eighteen:
if mode = 2:   crsbreak -9pt·cf;
fi.

subroutine twentyfour:
if mode = 2:   crsbreak (ph + pb - 12pt)·cf;
fi.

subroutine thirty:
if mode = 2:   crsbreak (ph + pb - 12pt)·cf;   crsbreak (ph + pb - 18pt) cf;
fi.

input mathdl;                                             % the large delimiters
input mathop;                                              % the large operators
input mexext;                      % nonstandard characters (any of the codes
          % '017, '037, '055-'057, '077, '104-'105, '140-'157, '167, '176, '177)
texinfo slant, 6pu, 3pu, 2pu, px, 18pu, 2pu, prt;
% (The calling file should supply the remaining texinfo.)
```

The file mathdl.mf

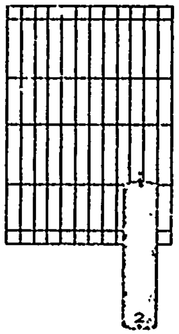
```
% Left parentheses (left-right symmetric with right ones)
charlist '000, '020, '022, '040, '060, 0;
subroutine biglp(var code, var units, var minps, var maxps, var height, var depth):
call charbegin(code, units, 0, 0, height, depth, 0);
new w18, w19;   w18 = round minps;   w19 = round maxps;
hpen;   x1 = x3 = good18(r - u);
top18y1 = round pixels·height,   bot18y3 = 1 - round pixels depth;   y2 =  5[y1, y3];
lft19x2 = round u;
y0 = y1;   y1 = y3;   x   = x1 = x1 + 1.875(units - 2)u;
draw (0..)|w18|1..|w19#|2{0, -1}..|w18|3(.  4).                               % stroke
```

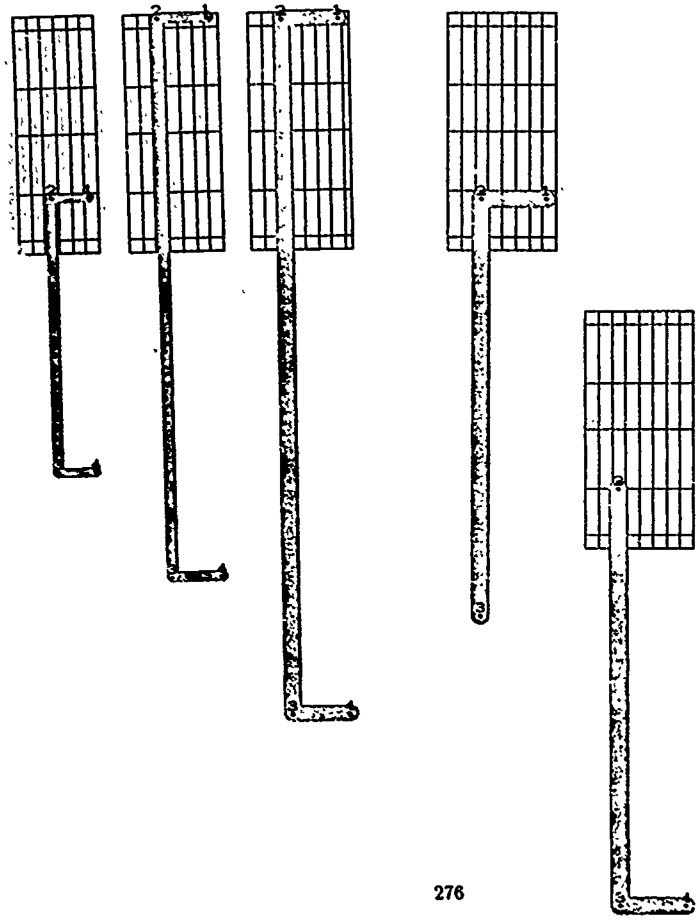


```
"12 point left parenthesis";
call biglp('000, 7, w0, w1, 0, 12pt).

"18 point left parenthesis";
call biglp('020, 9, w10, bold, 0, 18pt);   call eighteen.

"24 point left parenthesis";
call biglp('022, 11, w10 + .2deltaw, bold + deltaw, ph + pb, 24pt − ph − pb),
call twentyfour.

"30 point left parenthesis";
call biglp('040, 11.5, w10 + .4deltaw, bold + 2deltaw, ph + pb, 30pt − ph − pb);
call thirty

subroutine biglp:   .                                % free up METAFONT's memory

new w98, w99;   w98 = round(w10 + .6deltaw);   w99 = round(bold + 3deltaw),
"Extensible left parenthesis-top";
call charbegin('060, 12, 0, 0, 0, 18pt, 0);
varchar '060, 0, '100, '102;                             % extensible left parenthesis
hpen;   x1 = good98(r − u);   top98y1 = 0,
lft99x2 = round u;   y2 = round(.5 − 18pt·pixels);
x0 = x1 + 1.875(10u);   y0 = y1;
draw (0..)|w98|1..|w99#|2{0, −1}.                             % upper part of stroke

"Extensible left parenthesis-bottom";
call charbegin('100, 12, 0, 0, 0, 18pt, 0),
hpen;   x3 = good98(r − u),   bot98y3 = round(.5 − 18pt·pixels);
lft99x2 = round u;   y2 = 0;
x4 = x3 + 1.875(10u);   y4 = y3;
draw |w99#|2{0, −1}..|w98|3(  .4).                            % lower part of stroke

"Extensible left parenthesis extension module",
call charbegin('102, 12, 0, 0, 0, 6pt, 0);
varchar 0, 0, 0, '102;                     % left parenthesis extension modules only
hpen;   lft99x1 = round u;   y1 = 0;
x2 = x1;   y2 = round(.5 − 6pt·pixels);
w99 draw 1..2.                                                % middle part of stroke
```

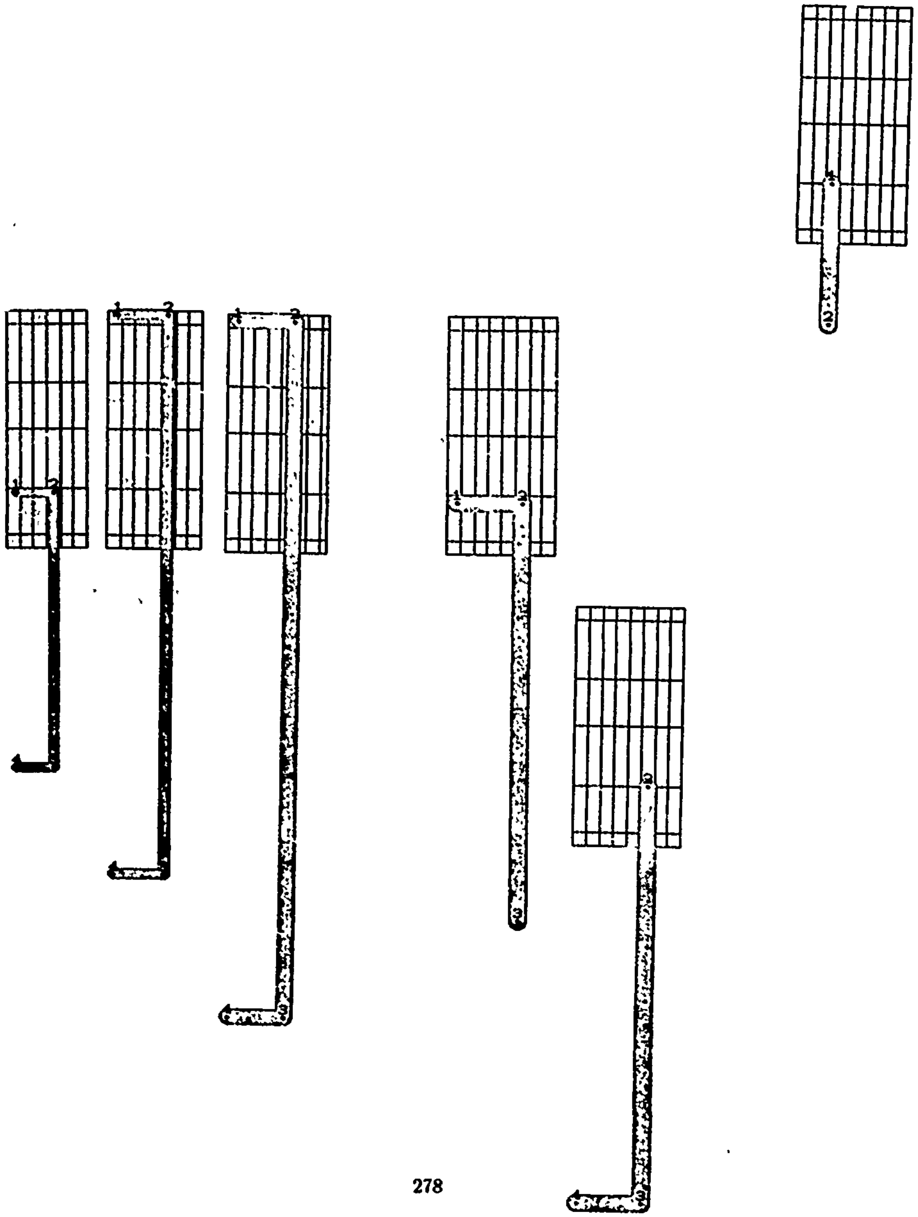


```
¢3 Right parentheses (left-right symmetric with left ones)
charlist ´001, ´021, ´023, ´041, ´061, 0;
subroutine bigrp(var code, var units, var minps, var maxps, var height, var depth):
call charbegin(code, units, 0, 0, height, depth, 0);
new w_18, w_19;   w_18 = round minps;   w_19 = round maxps;
hpen;   x_1 = x_1,   r − x_1 = good_18(r − u);
top_18 y_1 = round pixels height;   bot_18 y_3 = 1 − round pixels·depth;   y_2 = .5[y_1, y_3];
lft_19(r − x_2) = round u;
y_0 = y_1;   y_1 = y_3;   x_0 = x_1 = x_1 − 1.875(units − 2)u;
draw (0..)|w_18|1. |w_19#|2{0, −1}..|w_18|3(..4).                          % stroke

"12 point right parenthesis";
call bigrp(´001, 7, w_0, w_1, 0, 12pt).

"18 point right parenthesis";
call bigrp(´021, 9, w_10, bold, 0, 18pt);   call eighteen.

"24 point right parenthesis";
call bigrp(´023, 11, w_10 + .2deltaw, bold + deltaw, ph + pb, 24pt − ph − pb);
call twentyfour.

"30 point right parenthesis";
call bigrp(´041, 11.5, w_10 + 4deltaw, bold + 2deltaw, ph + pb, 30pt − ph − pb);
call thirty.

subroutine bigrp:  .                                  % free up METAFONT's memory

new w_98, w_99;   w_98 = round(w_10 + .6deltaw);   w_99 = round(bold + 3deltaw);
"Extensible right parenthesis-top";
call charbegin(´061, 12, 0, 0, 0, 18pt, 0);
varchar ´061, 0, ´101, ´103;                         % extensible right parenthesis
hpen;   r − x_1 = good_98(r − u);   top_98 y_1 = 0;
lft_99(r − x_2) = round u;   y_2 = round(.5 − 18pt pixels);
x_0 = x_1 − 1.875(10u);   y_0 = y_1;
draw (0..)|w_98|1..|w_99#|2{0, −1}.                          % upper part of stroke

"Extensible right parenthesis-bottom";
call charbegin(´101, 12, 0, 0, 0, 18pt, 0);
hpen;   r − x_3 = good_98(r − u);   bot_98 y_3 = round(.5 − 18pt pixels);
lft_99(r − x_2) = round u;   y_2 = 0;
x_1 = x_3 − 1.875(10u);   y_1 = y_3;
draw |w_99#|2{0, −1}..|w_98|3(..4).                          % lower part of stroke
```

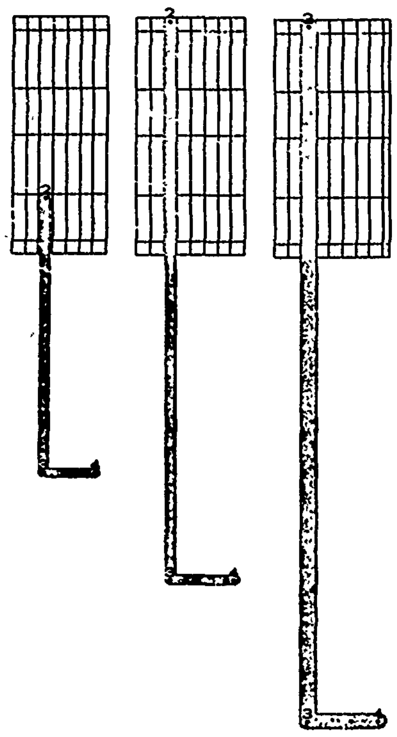


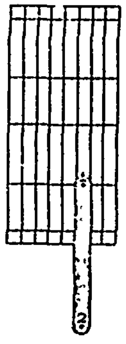


```
"Extensible right parenthesis-extensi n module";
call charbegin('103, 12, 0, 0, 0, 6pt, 0);
varchar 0, 0, 0, '!03;                      % right parenthesis extension modules only
hpen;   lft99(r − x1) = round u;   y1 = 0;
x2 = x1;   y2 = round(.5 − 6pt·pixels),
w99 draw 1..2.                                          % middle part of stroke

% Left brackets (left-right symmetric with right ones)
charlist '002, '024, '042, '062, 0;
subroutine biglb(var code, var units, var psize, var height, var depth):
call charbegin(code, units, 0, 0, height, depth, 0),
new w19;   w19 = round psize;
cpen;   x1 = x1 = good19(r − .75u);   x2 = x3 = good19(2.5u);
top19y1 = round pixels·height;   bot19y1 = 1 − round pixels depth;   y1 = y2,   y3 = y1;
w19 draw 1..2..2..3..3. 4.                                            % stroke

"12 point left bracket";
call biglb('002, 6, w10, 0, 12pt)

"24 point left bracket";
call biglb('024, 7, w10 + 2deltaw, ph + pb, 24pt − ph − pb);
call twentyfour.

"30 point left bracket";
call biglb('042, 7 5, w1 − 8deltaw, ph + pb, 30pt − ph − pb);
call thirty.

subroutine biglb:   .                                 % free up METAFONT's memory

new w99;   w99 = round(w1 − .6deltaw);
"Extensible left bracket top";
call charbegin('062, 8, 0, 0, 0, 18pt, 0);
varchar '062, 0, '064, '066;                            % extensible left bracket
cpen;   x1 = good99(r − .75u);   top99y1 = 0;
x2 = good99 2.5u;   y2 = y1;
x3 = x2;   y3 = round(.5 − 18pt pixels);
w99 draw 1..2..2..3.                                    % upper part of stroke

"Extensible left bracket-bottom";
call charbegin('064, 8, 0, 0, 0, 18pt, 0);
varchar 0, 0, '064, '066;                          % extensible left floor bracket
cpen;   x1 = good99(r − .75u);   bot99y1 = round(.5 − 18pt pixels);
x3 = good99 2.5u,   y3 = y1;
x2 = x1;   y2 = 0;
w99 draw 2 .3..3..4.                                    % lower part of stroke
```

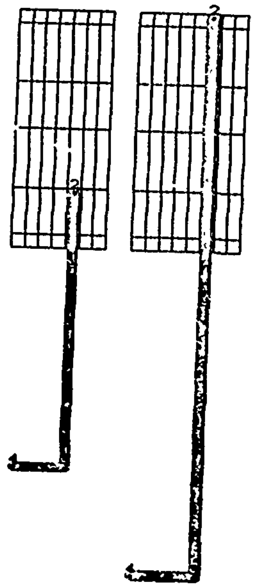


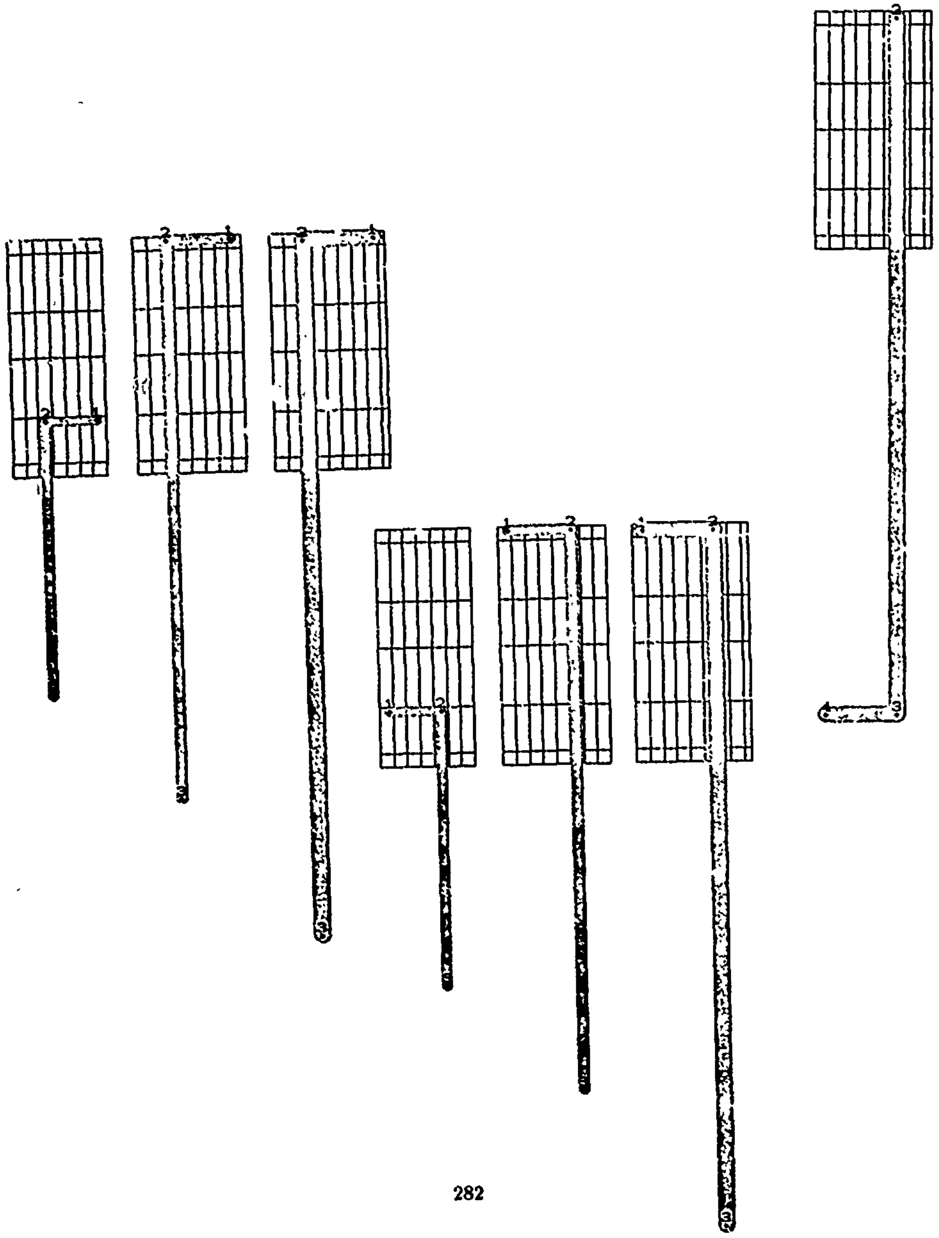
```
"Extensible left bracket extension module",
call charbegin('066, 8, 0, 0, 0, 6pt, 0);
varchar '062, 0, 0, '066;                                    % extensible left ceiling bracket
cpen;   x1 = good99 2.5u,   y1 = 0;
x2 = x1;   y2 = round(.5 — 6pt·pixels);
w99 draw 1..2.                                               % middle part of stroke

% Right brackets (left-right symmetric with left ones)
charlist '003, '025, '043, '063, 0;
subroutine bigrb(var code, var units, var psize, var height, var depth):
call charbegin(code, units, 0, 0, height, depth, 0);
new w19;   w19 = round psize,
cpen;   x1 = x1;   r — x1 = good19(r — .75u);   x2 = x1;   r — x2 = good19(2.5u);
top19y1 = round pixels·height;   bot19y3 = 1 — round pixels depth;   y1 = y2;   y3 = y1;
w19 draw 1..2..2..3..3..4.                                                 % stroke

"12 point right bracket";
call bigrb('003, 6, w10, 0, 12pt)

"24 point right bracket";
call bigrb('025, 7, w10 + .2deltaw, ph + pb, 24pt — ph — pb);
call twentyfour.

"30 point right bracket";
call bigrb('043, 7.5, w1 — 8deltaw, ph + pb, 30pt — ph — pb);
call thirty.

subroutine bigrb:   .                                        % free up METAFONT's memory

new w99;   w99 = round(w1 — .6deltaw);
"Extensible right bracket-top";
call charbegin('063, 8, 0, 0, 0, 18pt, 0);
varchar '063, 0, '065, '067;                                 % extensible right bracket
cpen;   r — x1 = good99(r — .75u);   top99y1 = 0,
r — x2 = good99 2.5u;   y2 = y1;
x3 = x2;   y3 = round(.5 — 18pt·pixels);
w99 draw 1..2..2..3.                                         % upper part of stroke

"Extensible right bracket-bottom";
call charbegin('065, 8, 0, 0, 0, 18pt, 0);
varchar 0, 0, '065, '067;                                    % extensible right floor bracket
cpen;   r — x1 = good99(r — .75u);   bot99y1 = round(.5 — 18pt pixels),
r — x3 = good99 2.5u;   y3 = y1;
x2 = x3;   y2 = 0;
w99 draw 2..3..3..4.                                         % lower part of stroke
```



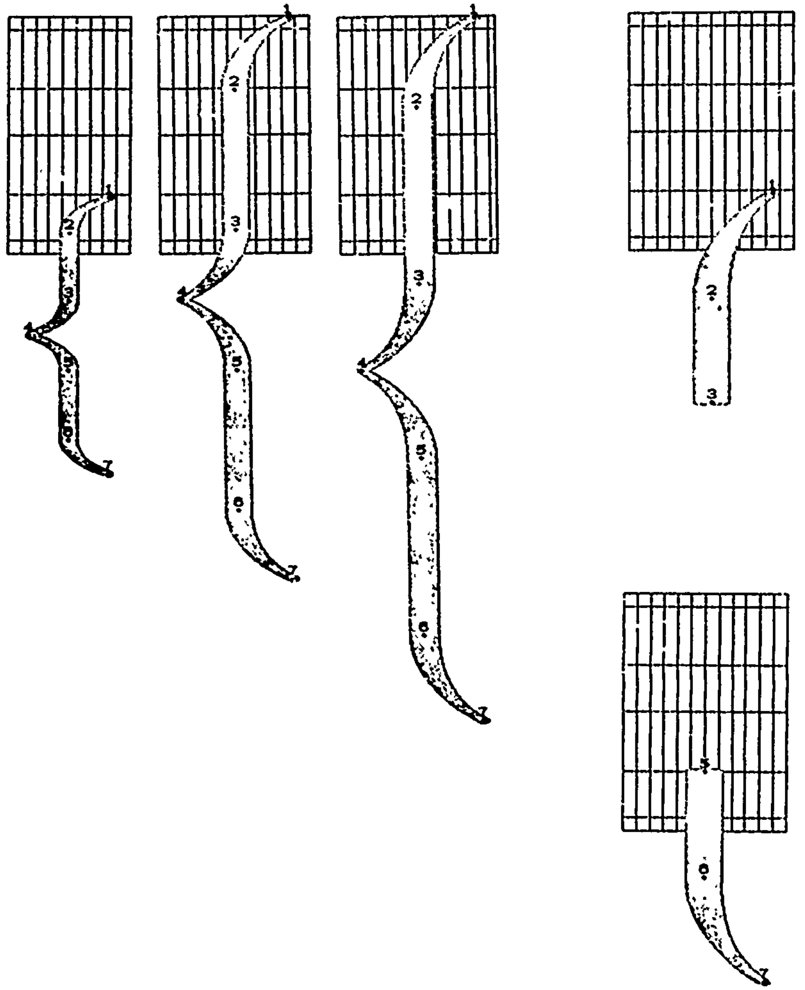


```
 Extensible right bracket-extension module";
call charbegin('067, 8, 0, 0, 0, 6pt, 0);
varchar '063, 0, 0, '067;                                    % extensible right ceiling bracket
cpen;   r - x1 = good99 2 5u;   y1 = 0;
x2 = x1;   y2 = round(.5 -- 6pt pixels);
w99 draw 1..2                                                  % middle part of stroke

% Left floor brackets (left-right symmetric with right ones)
charlist '004, '026, '044, '064, 0;
subroutine biglfb(var code, var units, var psize, var height, var depth)·
call charbegin(code, unit., 0, 0, height, depth, 0),
new w19;   w19 = round psize;
cpen;   x1 = good19(: -- .75u);   x2 == x3 = good19(2.5u);
top19y2 = round pi :els height;   bot19y3 = 1 - round pixels·depth;   y3 = y4;
w19 draw 2..3..3 .4.                                                        % stroke

"12 point left floor bracket";
call biglfb('004, 7, w10, 0, 12pt).

"24 point left floor bracket";
call biglfb('026, 8, w19 +  2deltaw, ph + pb, 24pt -  ph - pb);
call twentyfour

"30 point left floor bracket",
call biglfb('044, 8 5, wt --  8deltaw, ph + pb, 30pt -- ph - pb);
call thirty.

subroutine biglfb:   .                              % free up METAFONT's memory

% Right floor brackets (left-right symmetric with left ones)
charlist '005, '027, '045, '065, 0;
subroutine bigrfb(var code, var units, 'ar psize  var height, var depth).
call charbegin(code, units, 0, 0, height, depth  0);
new w19;   w19 = round psize;
cpen,   r - x1 = good19(r - - 75u);   x2 = x3;   r - x2 == good19(2 5u);
top19y2 = round pixels·height;   bot19y3 = 1 -  round pixels depth,   y1 = y1,
w19 draw 2 .3..3. 4.                                                        % stroke

"12 point right floor bracket";
call bigrfb('005, 7, w10, 0. 12pt).

"24 point right floor bracket";
call bigrfb('027, 8, w10 + .2deltaw, ph + pb, 24pt - ph - pb),
call twentyfour.
```

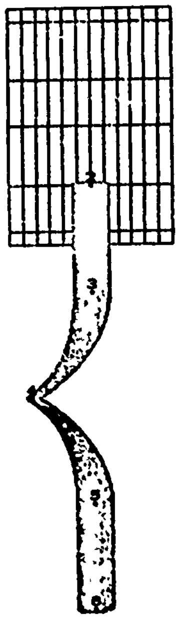


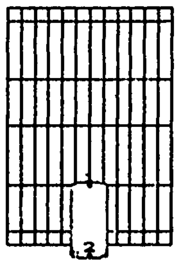


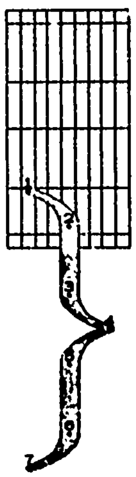
```
"30 point right floor bracket";
call bigrfb('015,8.5, w1 — .8deltaw, ph + pb, 30pt — ph — pb);
call thirty.

subroutine bigrfb: .                                        % free up METAFONT's memory

% Left ceiling brackets (left-right symmetric with right ones)
charlist '006, '030, '046, '066, 0;
subroutine biglcb(var code, var units, var psize, var height, var depth):
call charbegin(code, units, 0, 0, height, depth, 0);
new w10;   w10 = round psize;
cpen;   x1 = good 10(r — .75u),   x2 = x1 = good 10(2.5u);
top 10y1 = round pixels·height,   bot 10y3 = 1 — round pixels·depth,   y1 = y2;
w10 draw 1..2..2..3.                                                          % stroke

"12 point left ceiling bracket",
call biglcb('006, 7, w10, 0, 12pt)

"24 point left ceiling bracket",
call biglcb('030, 8, w10 + .2deltaw, ph + pb, 24pt — ph — pb),
call twentyfour.

"30 point left ceiling bracket",
call biglcb('046, 8.5, w1 — .8deltaw, ph + pb, 30pt — ph — pb);
call thirty.

subroutine biglcb: .                                        % free up METAFONT's memory

% Right ceiling brackets (left-right symmetric with left ones)
charlist '007, '031, '047, '067, 0;
subroutine bigrcb(var code, var units, var psize, var height, var depth):
call charbegin(code, units, 0, 0, height, depth, 0),
new w10;   w10 = round psize,
cpen;   r — x1 = good 10(r — .75u);   x2 = x1,   r — x3 = good 10(2.5u),
top 10y1 = round pixels·height;   bot 10y3 = 1 — round pixels·depth,   y1 = y2,
w10 draw 1..2..2..3.                                                          % stroke

"12 point right ceiling bracket";
call bigrcb('007, 7, w10, 0, 12pt)

"24 point right ceiling bracket",
call bigrcb('031, 8, w10 + .2deltaw, ph + pb, 24pt — ph — pb);
call twentyfour.

"30 point right ceiling bracket";
call bigrcb('047, 8.5, w1 — .8deltaw, ph + pb, 30pt — ph — pb);
call thirty.
```

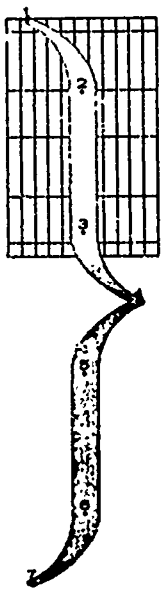


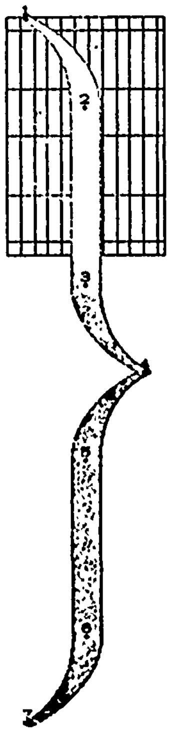
```
subroutine bigrcb:  .                                      % free up METAFONT's memory

% Left braces (left-right symmetric with right ones)
charlist '010, '032, '050, '070, 0,
subroutine biglbr(var code, var units, var minps, var maxps, var height, var depth).
call charbegin(code, units, 0, 0, height, depth, 0);
new w18, w19;   w18 = round minps;   w19 = round maxps;
hpen;  x2 = x3 = x5 = x6 = good19(.5r);
x1 − x2 = x2 − x4 = .5(units − 3)u + eps;   x1 = x7;
top19y1 = round height pixels,   bot19y7 = 1 − round pixels depth;
y4 = .5[y1, y7] = good0(.5[y1, y7]);
y1 − y2 = y3 − y4 = y5 − y6 = (y1 − y4)/4;
draw |w18#|1{3(x2 − x1), y2 − y1} .. |w19#|2{0, −1} .. |w19#|3{0, −1} ..
     |w18#|4{3(x4 − x3), y4 − y3};                                        % upper stem
draw |w18#|7{3(x6 − x7), y6 − y7} .. |w19#|6{0, 1} .. |w19#|5{0, 1} ..
     |w18#|4{3(x4 − x5), y4 − y5}.                                        % lower stem

"12 point left brace";
call biglbr('010, 9, w0, w1, 0, 12pt).

"24 point left brace";
call biglbr('032, 11, w10 + .2deltaw, bold + deltaw, ph + pb, 24pt − ph − pb);
call twentyfour.

"30 point left brace";
call biglbr('050, 11.5, w10 + .4deltaw, bold + 2deltaw, ph + pb, 30pt − ph − pb);
call thirty.

subroutine biglbr:  .                                      % free up METAFONT's memory

new w98, w99,   w98 = round(w10 + 6deltaw);   w99 = round(bold + 4deltaw);
"Extensible left brace top";
call charbegin('070, 12, 0, 0, 0, 9pt, 0);
varchar '070, '074, '072, '076,                                    % extensible left brace
hpen;  x2 = x3 = good99(.5r);   x1 − x2 = 4.5u + eps;
top99y1 = 0,   y2 = .5[y1, y3],   y3 = round(.5 − 9pt·pixels);
draw |w98#|1{3(x2 − x1), y2 − y1} .. |w99#|2{0, −1} ..
     3{0, −1}.                                                     % top of upper stem

"Extensible left brace bottom";
call charbegin('072, 12, 0, 0, 0, 9pt, 0);
varchar '070, 0, '073, '076;                         % top left, bottom right combination
hpen;  x6 = x5 = good99(.5r);   x7 − x6 = 4.5u + eps;
y5 = 0;   y6 = .5[y5, y7],   bot99y7 = round(.5 − 9pt pixels);
draw |w98#|7{3(x6 − x7), y6 − y7} .. |w99#|6{0, 1} ..
     5{0, 1}.                                                      % bottom of lower stem
```



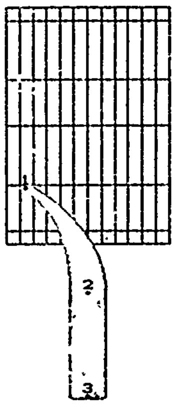


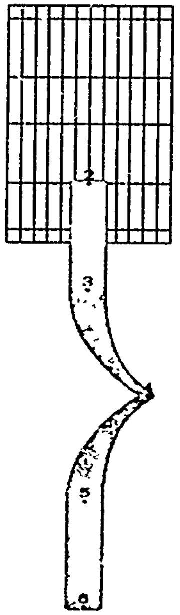


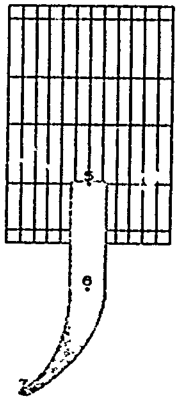


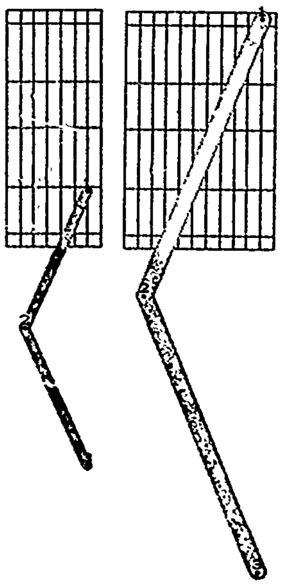


```
"Extensible left brace middle";
call charbegin('074, 12, 0, 0, 0, 18pt, 0);
varchar 0, 0, 0, '066;                              % left bracket extension modules only
hpen;   x2 = x6 = x4 = x5 = good99(.5r);   x3 -- x4 = 4.5u + eps;
y2 = good6 .25;   y6 = good6(.5 -- 18pt·pixels);   y4 = good6(.5[y2, y6]);
y4 = .5[y2, y4];   y3 -- y4 = y4 -- y5;
draw |w99#|2 . . |w99#|3{0, --1} . .
     |w18#|4{3(x4 -- x3), y4 -- y3};                            % bottom of upper stem
draw |w99#|6 . . |w99#|5{0, 1} . .
     |w18#|4{3(x4 -- x5), y4 -- y5}.                             % top of lower stem

"Extensible braces extension module";
call charbegin('076, 12, 0, 0, 0, 3pt, 0);
varchar 0, 0, 0, '076;                               % brace extension modules only
hpen,   x1 = x2 = good99(.5r);   y1 = 0;   y2 = round(.5 -- 3pt·pixels);
w99 draw 1 . . 2.                                             % middle part of stroke

% Right braces (left-right symmetric with left ones)
charlist '011, '033, '051, '071, 0;
subroutine bigrbr(var code, var units, var minps, var maxps, var height, var depth):
call charbegin(code, units, 0, 0, height, depth, 0);
new w18, w19;   w18 = round minps,   w19 = round maxps;
hpen;   x2 = x3 = x5 = x6 = good19(.5r);
x1 -- x2 = x2 -- x4 = --.5(units -- 3)u + eps;   x1 = x7;
top19y1 = round height·pixels;   bot19y7 = 1 -- round pixels·depth;
y4 = .5[y1, y7] = good0(.5[y1, y7]);
y1 -- y2 = y3 -- y4 = y6 -- y7 = (y1 -- y7)/4;
draw |w18#|1{3(x2 -- x1), y2 -- y1} . . |w19#|2{0, -- 1} . . |w19#|3{0, --1} . .
     |w18#|4{3(x4 -- x3), y4 -- y3};                                   % upper stem
draw |w18#|7{3(x6 -- x7), y6 -- y7} . . |w19#|6{0, 1} . . |w19#|5{0, 1} . .
     |w18#|4{3(x4 -- x5), y4 -- y5}.                                   % lower stem

"12 point right brace";
call bigrbr('011, 9, w0, w1, 0, 12pt).

"24 point right brace";
call bigrbr('053, 11, w10 + .2deltaw, bold + deltaw, ph + pb, 24pt -- ph -- pb),
call twentyfour.

"30 point right brace";
call bigrbr('051, 11.5, w10 + .4deltaw, bold + 2deltaw, ph + pb, 30pt -- ph -- pb),
call thirty

subroutine bigrbr.                                     % free up METAFONT's memory
```

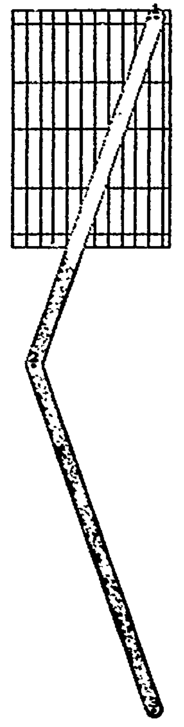


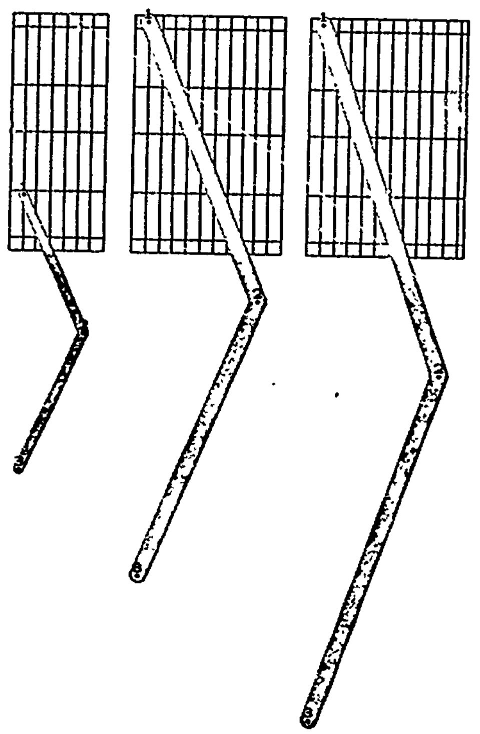


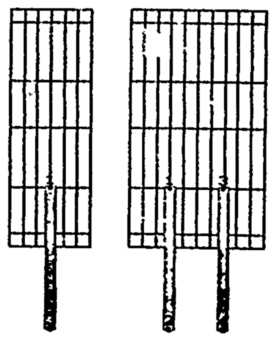




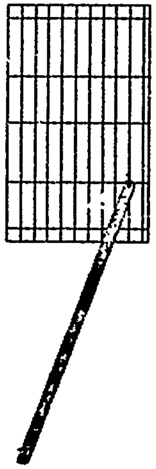
```
new w98, w99;   w98 = round(w10 + 6deltaw),   w99 = round(bold + 4deltaw),
"Extensible right brace top";
call charbegin('071, 12, 0, 0, 0, 9pt, 0);
varchar '071, '075, '073, '076,                              % extensible right brace
hpen;   x2 = x1 = good99(.5r),   x1 - x2 = - 4.5u + eps,
top99y1 = 0;   y2 = .5[y1, y3],   y3 = round(.5 - 9pt pixels);
draw |w98#|1{3(x2 - x1), y2 - y1} . |w99#|2{0, -1}
     3{0, -1}.                                                  % top of upper stem

"Extensible right brace-bottom";
call charbegin('073, 12, 0, 0, 0, 9pt, 0)
varchar '071, 0, '072, '076,                    % top right, bottom le   combination
hpen,   x6 = x5 = good99(.5r),   x7 - x6 = - 4.5u + eps;
y5 = 0;   y6 = .5[y5, y7];   bot99y7 = round(.5 - 9pt pixels),
draw |w98#|7{3(x6 - x7), y6 - y7}   |w99#|6{0, 1}
     5{0, 1}.                                                % bottom of lower stem

"Extensible right brace middle",
call charbegin('075, 12, 0, 0, 0, 18pt, 0);
varchar 0, 0, 0, '067;                           % right bracket extension modules only
hpen;   x2 = x6 = x3 = x5 = good99(.5r),   x1 - x3 = -4.5u + eps,
y2 = good6 25;   y6 = good6(.5 - 18pt pixels),   y1 = good6(.5[y2, y6]),
y3 = .5[y2, y1];   y1 - y3 = y5 - y6;
draw |w99#|2 . . |w99#|3{0, -1} . .
     |w98#|4{3(x1 - x3), y1 - y3};                            % bottom of upper stem
draw |w99#|6   |w99#|5{0, 1} . .
     |w98#|4{3(x1 - x5), y1 - y5}.                                % top of lower stem

% Left angle brackets (left-right symmetric with right ones)
charlist '012, '034, '052;
subroutine biglab(var code, var units, var psize, var height, var depth).
call charbegin(code, units, 0, 0, height, depth, 0),
new w19,   w19 = round psize,
cpen;   x1 = x3 = good19(r - u),   lft19x2 = round u,
top19y1 = round pixels·height,   bot19y3 = 1 - round pixels depth;
y2 = good19(.5[y1, y3]);
w19 draw 1 . . 2 . . 2 . . 3.                                            % stroke

"12 point left angle bracket",
call biglab('012, 7, w10, 0, 12pt).

"24 point left angle bracket",
call biglab('034, 11, w1 - deltaw, ph + pb, 24pt - ph - pb),
call twentyfour.
```

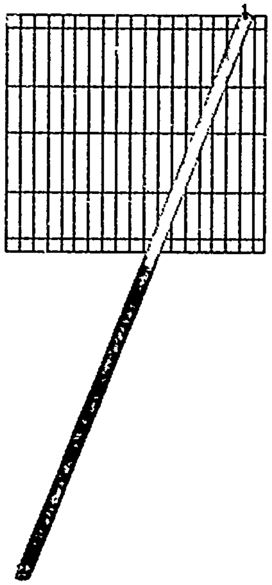


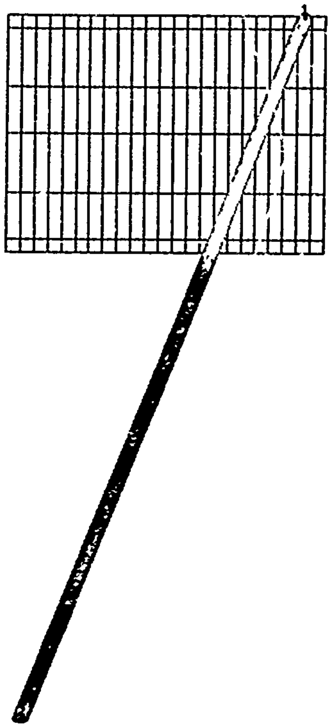


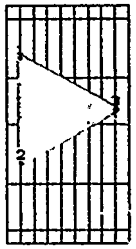


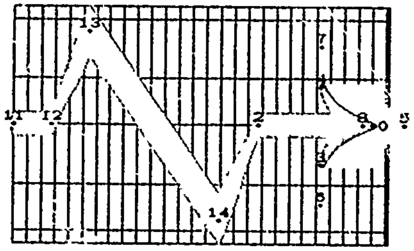
```
"30 point left angle bracket";
call biglab('052, 11.5, w_1 − 8deltaw, ph + pb, 30pt − ph − pb);
call thirty.

subroutine biglab: .                                   % free up METAFONT's memory

% Right angle brackets (left-right symmetric with left ones)
charlist '013, '035, '053;
subroutine bigrab(var code, var units, var psize, var height, var depth):
call charbegin(code, units, 0, 0, height, depth, 0);
new w_{99};   w_{99} = round psize;
cpen;   x_1 = x_3;   r − x_1 = good_{99}(r − u);   lft_{99}(r − x_2) = round u,
top_{99}y_1 = round pixels height;   bot_{99}y_3 = 1 − round pixels·depth;
y_2 = good_{99}(.5[y_1, y_3]);
w_{99} draw 1..2..3.                                                        % stroke

"12 point right angle bracket";
call bigrab('013, 7, w_{10}, 0, 12pt).

"24 point right angle bracket";
call bigrab('035, 11, w_1 − deltaw, ph + pb, 24pt − ph − pb);
call twentyfour.

"30 point right angle bracket";
call bigrab('053, 11.5, w_1 − 8deltaw, ph + pb, 30pt − ph − pb),
call thirty.

subroutine bigrab: .                                   % free up METAFONT's memory

% Vertical lines
new w_{99},   w_{99} = round(w_{10} + 2deltaw);
"Extensible vertical line extension module";
charlist '014, 0;
call charbegin('014, 6, 0, 0, 0, 6pt, 0);
varchar 0, 0, 0, '014;                                   % extensible vertical line
hpen;   x_1 = x_2 = good_{99} .5r,   y_1 = 0;   y_2 = round(.5 − 6pt pixels);
w_{99} draw 1..2.                                                             % stem

"Extensible double vertical line extension module",
charlist '015, 0;
call charbegin('015, 10, 0, 0, 0, 6pt, 0),
varchar 0, 0, 0, '015;                            % extensible double vertical line
hpen;   x_1 = x_2 = good_{99} 3r,   x_3 = x_4 = r − x_1;
y_1 = y_3 = 0;   y_2 = y_4 = round(.5 − 6pt pixels);
w_{99} draw 1..2;   draw 3..4.                                                   % stems
```



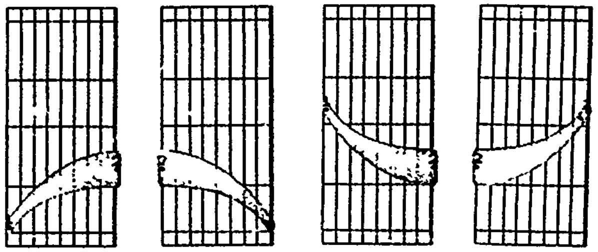


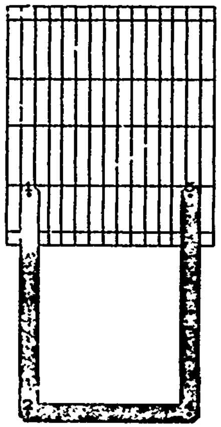






```
% Slashes
charlist ´016, ´036, ´054;
subroutine bigslash(var code, var units, var psize,
      var height, var depth)
call charbegin(code, units, 0, 0, height, depth, 0);
new w10;   w10 = round psize;
hpen;   rt10x1 = round(r − u),   lft10x2 = round u,
top10y1 = round pixels·height,   bot10y2 = 1 − round pixels depth,
w10 draw 1 . 2                                                  % diagonal

"12 point slash";
call bigslash(´016, 10.4, w10 + 2deltaw, 0, 12pt)

"24 point slash";
call bigslash(´036, 18 8, w10 + deltaw, ph + pb, 24pt − ph − pb);
call twentyfour.

"30 point slash";
call bigslash(´054, 23, w10 + 1 5deltaw, ph + pb, 30pt − ph − pb);
call thirty.

% The bigslash subroutine is used also to make extrabold slashes


"Black triangle",
call charbegin( 170, 9, 0, 0, 6 25pt, 0, 0):
hpen;   x1 = x2 = good0u,   x3 = r − x1,   y3 = good0 3.125pt pixels,
y1 − y3 = y3 − y2 = (x3 − x1)/(sqrt 3);
w0 ddraw 1   3, 2 . . 3.                                 % fill in the triangle

"Arrow for errata lists";
call charbegin(´171, 27 2, 0 0, ph + pb, pd + pb, 0);
vpen,   x2 = good0 65r,   rt5x1 − x0 = round(r − u):
y3 − y1 − y2 − y5 − y6 = y11 − y12 = good10u,
new w9,   w9 = 2w5,   top9y13 = h + b,   bot9y14 −   d − b,
x11 = 0,   x12 = 1r;   x13 = 2r,   x14 = 55r,
draw |w5|11 . 12 . |w5#|12  |w9#|13 . 13  14 . .
     |w9#|14  |w5#|2 . 2 . . 1;                                 % main arrow
hpen;   rt1x8 = x0;
x5 −  x5 = x4 − x3 − 3u + eps,   x3 = x1 = x6 = x7,
y1 − y6 = y1 − y4 = y1 − y1 = y7 − y1 = 24h + eps,
epen#,   w5 + w1 draw (5   )8  3(  6);           % erase excess at lower right
hpen,   draw (|w5|5   )8 . |w0|3(   6);                       % lower point
epen#,   w5 + w1 draw (5   )8  4( . 7);          % erase excess at upper right
hpen,   draw (|w1|5 . )8   |w0|4(   7).                       % upper point
```

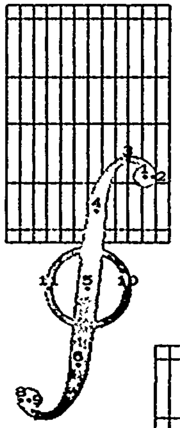


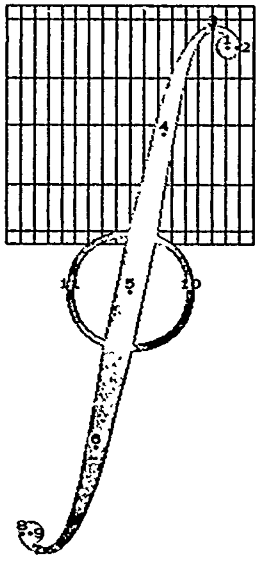


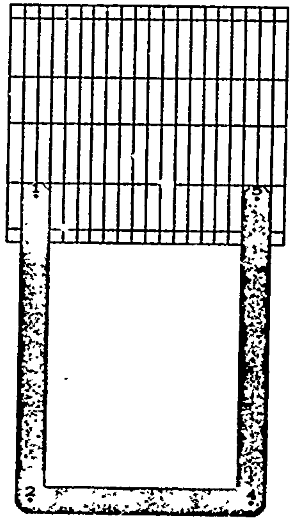
```
% Parts for extensible horizontal bra. es to match vertical ones
new rulcht, w98, w99;
rulcht =  5[pwii, pwiii] + 4(pwii -- pwi);                    % height of extension rule
w98 == round(w10 + .6dcltaw);
w99 = round(bold + 4dcltaw);                                  % corresponds to rule height
"Extensible downwards brace -left";
call charbegin('172, 4.5pt/pu, 0, 0, rulcht, 0, 0);
vpen;   lft98x1 = 0;   x2 = r + 1;
bot99y2 = 0;   y1 = y2 - 4 5u -- eps;
draw |w98#|1{x2 -- x1, 3(y2 - y1)} . . |w99#|2{1, C}.                           % point

"Extensible downwards brace-right";
call charbegin('173, 4.5pt/pu, 0, 0, rulcht, 0, 0);
vpen;   rt98x1 == r + 1;   x2 = 0;
bot99y2 = 0;   y1 = y2 - 4.5u -- eps;
draw |w98#|1{x2 - x1, 3(y2 - y1)} . . |w99#|2{-1, 0}.                           % point

"Extensible upwards brace-left";
call charbegin('174, 4 5pt/pu, 0, 0, rulcht, 0, 0);
vpen;   lft98x1 = 0;   x2 = r + 1;
bot99y2 = 0;   y1 = y2 + 4.5u + eps;
draw |w98#|1{x2 - x1, 3(y2 -- y1)}   |w99#|2{1, 0}.                             % point

"Extensible upwards brace right";
call charbegin('175, 4 5pt/pu, 0, 0, rulcht, 0, 0);
vpen;   rt98x1 == r + 1;   x2 = 0;
bot99y2 = 0;   y1 == y2 + 4.5u + eps;
draw |w98#|1{x2 - x1, 3(y2 - y1)}  . |w99#|2{-1, 0}                             % point
```

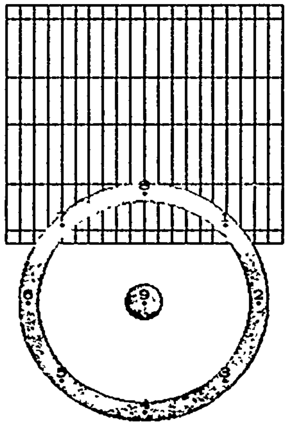
The file mathop mf

```
% Square union signs
charlist '106, '107;
subroutine bigsqun(var code, var units, var size, var depth):
call charbegin(code, units, 0, 0, 0, depth, 0);
new w19;   w19 = round size;
cpen;   lft19x1 = round u;   x2 = x1;   x1 == x5 = r - x1;
top19y1 = 0;   b   y2 = 1 - round depth·pixels;
y2 = y1;   y5 =
size draw 2.                                                                     % bar
draw 1  .2;             5                                                        % stems

"12 point square union sign";
call bigsqun('106, 15, w1, 10pt).
```

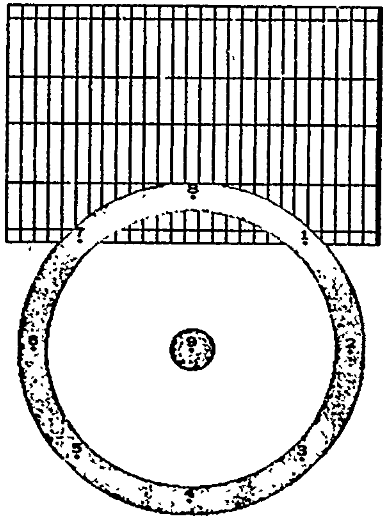


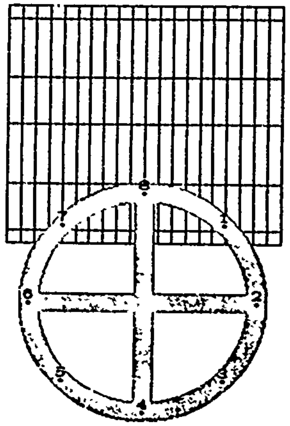


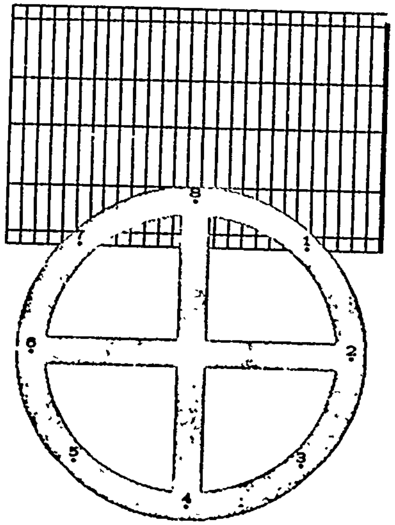


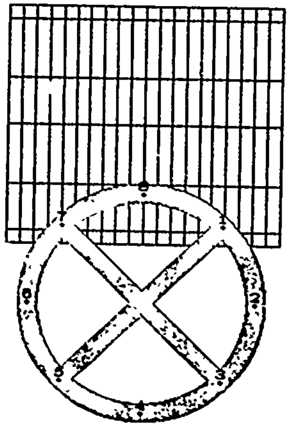


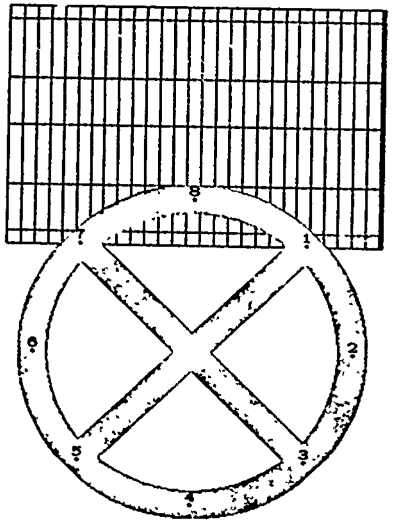
```
"18 point square union sign";
call bigsqun('107, 20, w3 + deltaw, 14pt),
call eighteen.

subroutine bigsqun:  .                                      % free up METAFONT's memory

% Contour integral signs
charlist '110, '111,
subroutine bigoint(var code, var units, var keyps, var maxps,
                         var dotps, var height, var depth, var kerncorr):
call charbegin(code, units, 0, 0, height, deoth, kerncorr);
new w18, w19;   w18 = round maxps;   w19 = round dotps;
hpen;   rt 19x1 = rt0x2 = round(r − u);   y1 = y2 = y3 − 75w19;
lft 19x9 = lft0x8 = round u,   y8 = y9 = y7 + 75w19,
x3 = r − 3u,   x7 = 3u;
top0y3 = round pixels height,   bot0y7 = 1 − round pixels depth,
x5 = good 18.5r;   y5 = 5[y3, y7];
x4 = x5 + .3(r − 10u);   y4 = y5 + .3(y3 − y7);
x6 = x5 − .3(r − 10u);   y6 = y5 − 3(y3 − y7);
cpen;   w19 draw 1;                                                            % upper bulb
draw 9;                                                                        % lower bulb
hpen;   draw |w0|2{0, 1} . |w0#|3{−1, 0}   |keyps|4{x6 − x4, y6 − y4}   |w18#|5.
     |keyps|6{x6 − x4, y6 − y4} . |w0#|7{−1, 0} .8{0, 1};                         % stem
x10 = good0.75r,   x5 = .5[x10, x11];   y10 = y11 = y5;
w0 draw 10{0, 1}..11{0, −1}. 10{0, 1}                                          % bowl

"12 point contour integral sign",
call bigoint('110, 12, w1, w2, bold, 10pt/9, 10pt, 3 5pu).

"24 point contour integral sign";
call bigoint('111, 18, w2, bold + 2deltaw, w1, ph + pb − 8/3pt,
                        24pt − ph − pb − 8/3pt, 8pu);
call twentyfour.

subroutine bigoint:  .                                      % free up METAFONT's memory

% Circle-dot operators
charlist '112, '113;
subroutine bigodot(var code, var units, var size, var dotsize, var depth)·
call charbegin(code, units, 0, 0, 0, depth, 0);
new w19,   w19 = round size,
cpen;   lft 19x6 = round u;   top 19y8 = 0;   x2 = r − x6,   bot 19y4 = 1 − round depth pixels,
call circle(1, 2, 3, 4, 5, 6, 7, 8, size);                                         % circle
x9 = .5[x6, x2];   y9 = .5[y8, y4];   dotsize draw 9.                                % dot

"12 point circle-dot operator";
call bigodot('112, 20, w1, bold + 4deltaw, 10pt).
```



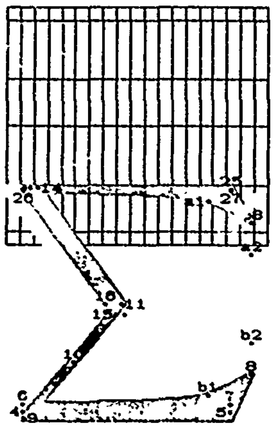


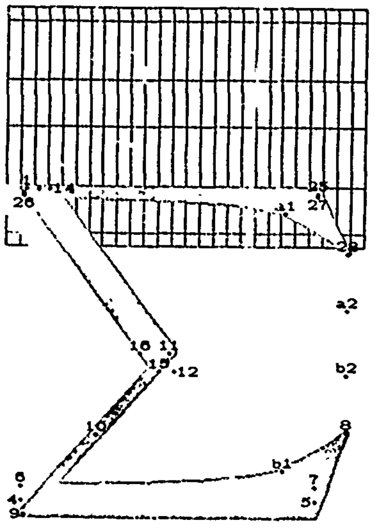






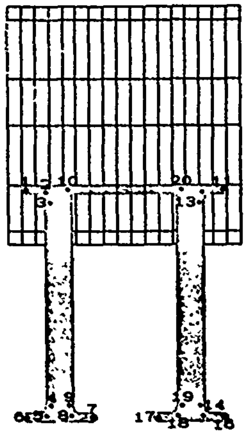
```
"18 point circle-dot operator";
call bigodot('113, 27.2, w1 + deltaw, bold + 6deltaw, 14pt);
call eighteen.

subroutine bigodot:  .                                  % free up METAFONT's memory

% Circle-plus operators
charlist '114, '115;
subroutine bigoplus(var code, var units, var size, var depth):
call charbegin(code, units, 0, 0, 0, depth, 0);
new w19;   w19 = round size;
cpen,   lft19x6 = round u;   top19y8 = 0,   x2 = r − x6;   bot19y1 = 1 − round depth·pixels;
call circle(1, 2, 3, 4, 5, 6, 7, 8, size);                                       % circle
w19 draw 2..6;   draw 4..8.                                                        % plus

"12 point circle-plus operator";
call bigoplus('114, 20, w1, 10pt).

"18 point circle-plus operator";
call bigoplus('115, 27.2, w1 + deltaw, 14pt);
call eighteen.

subroutine bigoplus:  .                                 % free up METAFONT's memory

% Circle-times operators
charlist '116, '117;
subroutine bigotimes(var code, var units, var size, var depth):
call charbegin(code, units, 0, 0, 0, depth, 0);
new w19;   w19 = round size;
cpen;   lft19x6 = round u;   top19y8 = 0,   x2 = r − x6,   bot19y1 = 1 − round depth pixels;
call circle(1, 2, 3, 4, 5, 6, 7, 8, size);                                       % circle
w19 draw 1..5;   draw 3..7. .                                                     % times

"12 point circle-times operator";
call bigotimes('116, 20, w1, 10pt).

"18 point circle-times operator";
call bigotimes('117, 27.2, w1 + deltaw, 14pt),
call eighteen.

subroutine bigotimes:                                   % free up METAFONT's memory
```

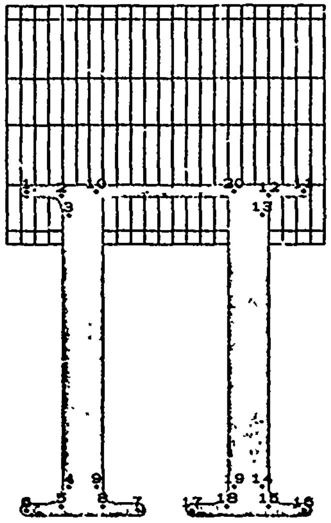




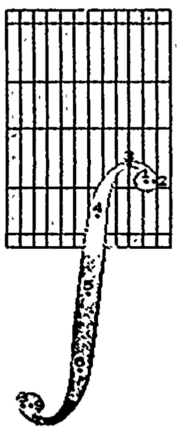
13
24

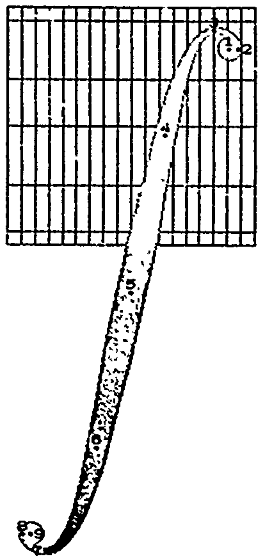
```
% Summation signs
charlist '120, '130;
subroutine bigsum(var code, var units, var minps, var maxps, var serif, var depth):
call charbegin(code, units, 0, 0, 0, depth, 0);
new w18, w19;   w18 = round minps aspect,   w19 = round maxps aspect,
hpen;   lft0x26 = round u;   rt0x28 = r − u,   x27 = good0(x28 − (r − 2u)/11);
new ss,   ss = 1.4aspect serif·u + eps.
if ss + u0 > 25depth·pixels   new ss,   ss = 25depth pixels − u0 + eps,
fi;
vpen,   top18y21 = top0y1 = 0,   y25 = y21,   bot0y26 = bot18y21,
y27 = y26,   y28 = y27 − ss;
bot19y4 = bot0y9 = 1 − round(depth pixels);   y5 = y4,
top0y6 = top19y4;   y7 = y6,   y8 = y7 + ss;
x21 = x26 = x1 = x6,   x25 = x27 = x5 = x7,   x8 = x28,
call `a arm(26, 27, 28);                                  % upper arm and serif
call `b arm(6, 7, 8);                                     % lower arm and serif
w18 draw 24..25;   w19 draw 4..5,                         % thicken bars of arms
if ucs = 0.   draw 5..8;   w18 draw 25..28,               % thicken bars of arms
else   if w0 ≠ w1.   draw |w19|5..|w0|8,                  % thicken lower serif
          draw |w18|25..|w0|28,                           % thicken upper serif
    else.   draw 5..8,   w18 draw 25..28;                 % thicken bars of arms
    fi;
fi;
new w18, w19;   w18 = round minps,   w19 = round maxps;
hpen;   lft18x1 = lft19x13 = lft0x21;   x9 = x1;   x10 = .5[x9, x11],
x16 = round(u + 1/11(r − 2u));   lft19x12 = lft0x15;
lft19x9 = x16;   rt19x9 = rt18x11,   rt19x11 = rt18x11;
y10 = .5[y9, y11];   y11 = y16 = .5[y1, y9],   y12 = y15,   y13 = y14 = y1,
new aa, bb;   lft18x15 = aa[lft18x1, x16];   y15 = aa[y1, y16],
lft18x15 = bb[x9, x11],   y15 = bb[y9, y11],
w19 draw 13..12,                                          % upper diagonal
lpen#;   w19 draw 1..15,                    % erase excess at upper left corner
hpen,   w18 draw 1..15;                           % sharpen upper left corner
rpen#,   w19 draw 10..11;                                 % erase excess at right
lpen#;   w19 draw 9..10,                                  % erase excess at left
hpen;   w18 draw 9..11;                                   % lower diagonal
draw 14..11.                                              % sharpen middle corner

"12 point summation sign";
call bigsum('120, 19, w10, w2, ucs, 10pt)

"18 point summation sign",
call bigsum('130, 26, w10 + deltaw, bold + 4deltaw, 1.8 * ucs, 14pt);
call eighteen.

subroutine bigsum: .                               % free up METAFONT's memory
```

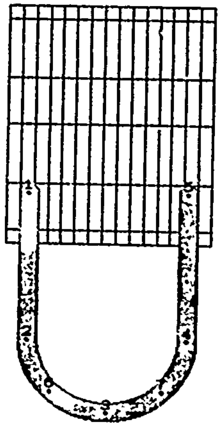


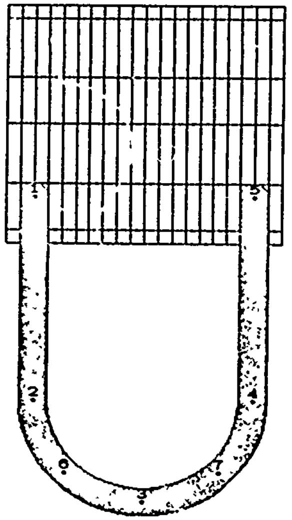


```
% Product signs
charlist ´121, ´131;
subroutine bigprod(var code, var units, var minps, var maxps,
      var serif, var ss, var depth):
call charbegin(code, units, 0, 0, 0, depth, 0);
new w18, w19;   w18 = round minps;   w19 = round maxps;
cpen;   lft18 x1 = round u;   x3 − x1 = round(serif·u + eps);
lft18 x3 = lft19 x99;   rt19 x99 = rt18 x10;
top18 y1 = 0;   y3 = y1 − ss;   y10 = y1;
x2 = 1/3[x1, 1/2[x1, x3]];   y2 = 1/3[y1, 1/2[y1, y3]];
bot18 y5 = 1 − round(depth·pixels);
y6 + y1 = y5 + y2 = y4 + y3,   x6 = x1;   x5 = x2;   x4 = x3;
x9 = x10;   x4 + x9 = x5 + x8 = x6 + x7;   y4 = y9;   y5 = y8,   y6 = y7;
y11 = y1;   y12 = y2;   y13 = y3;   y14 = y4;   y15 = y5;
y16 = y6;   y17 = y7;   y18 = y8;   y19 = y9;   y20 = y10;
r = x11 + x1 = x12 + x2 = x13 + x3 = x14 + x4 = x15 + x5 =
      x16 + x6 = x17 + x7 = x18 + x8 = x19 + x9 = x20 + x10;
w18 ddraw 1{1,0} .2..3{0,−1}..4{0,−1}..5   6{−1,0},
      10..10..10{0,−1}..9{0,−1} .8..7{1,0},                % left stem and serifs
ddraw 11{−1,0}..12..13{0,−1}..14{0,−1}..15   16{1,0},
      20..20 .20{0,−1}   19{0,−1}..18..17{−1,0};           % right stem and serifs
draw 10..20.                                                          % bar

"12 point product sign";
call bigprod(´121, 17, w10, bold + deltaw, ucs, s, 10pt).

"18 point product sign";
call bigprod(´131, 23, w10 + deltaw, bold + 5deltaw, 1.8 * ucs, 1.8s, 14pt),
call eighteen.

subroutine bigprod: .                                  % free up METAFONT's memory
```

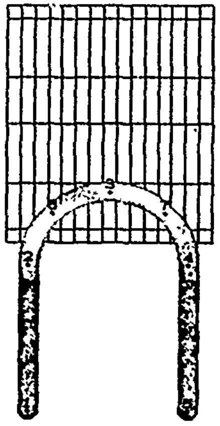


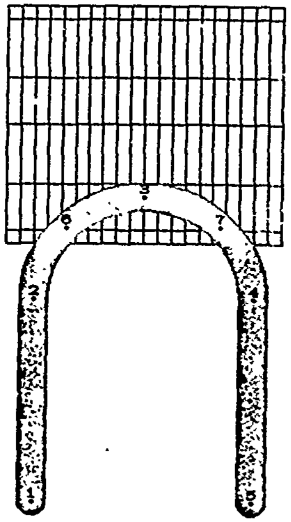


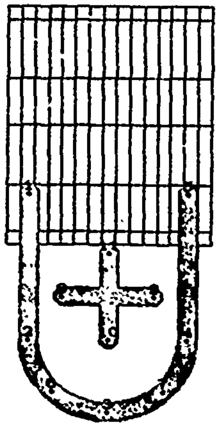


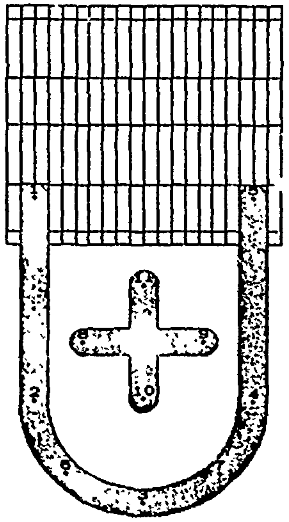


```
% Integral signs
charlist '122, '132;
subroutine bigint(var code, var units, var keyps, var maxps,
                          var dotps, var height, var depth, var kerncorr)
call charbegin(code, units, 0, 0, height, depth, kerncorr);
new w18, w19;   w18 = round maxps;   w19 = round dotps;
hpen;   rt19x1 = rt0x2 = round(r − u);   y1 = y2 = y3 − .75w19,
lft19x9 = lft0x8 = round u;   y8 = y9 = y7 + .75w19;
x3 = r − 3u,   x7 = 3u,
top0y3 = round pixels height,   bot0y7 = 1 − round pixels·depth,
x5 = good18 5r;   y5 = .5[y3, y7];
x4 = x5 + .3(r − 10u);   y4 = y5 + 3(y3 − y7);
x6 = x5 − .3(r − 10u);   y6 = y5 − 3(y3 − y7);
cpen;   w19 draw 1;                                                   % upper bulb
draw 9;                                                               % lower bulb
hpen;   draw |w0|2{0, 1} . |w0#|3{−1, 0} . . |keyps|4{x6 − x4, y6 − y4}   |w18#|5 . .
     |keyps|6{x6 − x4, y6 − y4} . |w0#|7{−1, 0}   8{0, 1}.              % stem

"12 point integral sign";
call bigint('122, 12, w1, w2, bold, 10pt/9, 10pt, 3.5pu).

"24 point integral sign";
call bigint('132, 18, w2, bold + 2deltaw, w1, ph + pb − 8/9pt,
                    24pt − ph − pb − 8/9pt, 8pu);
call twentyfour.

subroutine bigint:  .                         % free up METAFONT's memory

% Set union signs
charlist '123, '133;
subroutine bigun(var code, var units, var size, var depth):
call charbegin(code, units, 0, 0, 0, depth, 0);
new w19;   w19 = round size;
cpen;   lft19x1 = round u;   x2 = x1;   x3 = r − x1,   x4 = x5 = r − x1;
top19y1 = 0;   bot19y3 = 1 − round depth·pixels;
y2 = y4 = 2/3[y1, y3];   y5 = y1;
call qcirc(3, 6, 2, size);   call qcirc(3, 7, 4, size);               % cup
size draw 1 . . 2;   draw 4 . . 5.                                    % stems

"12 point set union sign";
call bigun('123, 15, w1, 10pt).

"18 point set union sign";
call bigun('133, 20, w3 + deltaw, 14pt);
call eighteen.

subroutine bigun:  .                          % free up METAFONT's memory
```

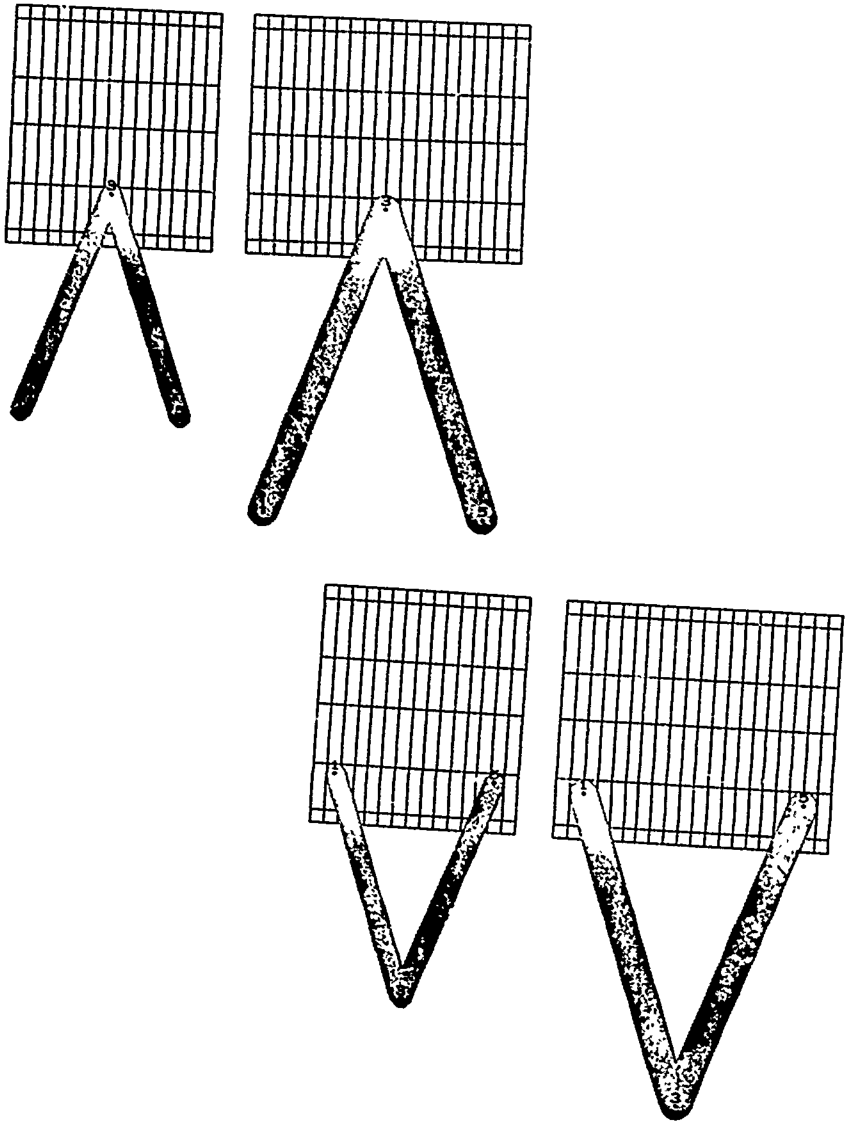




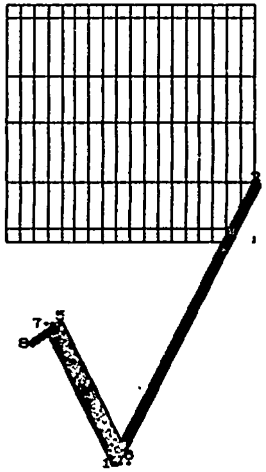


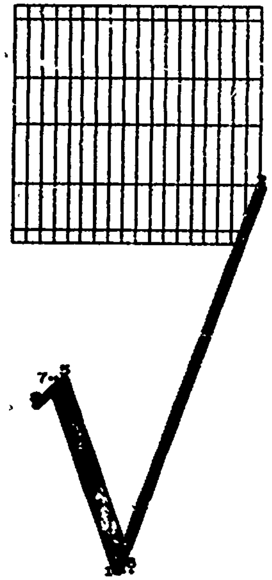


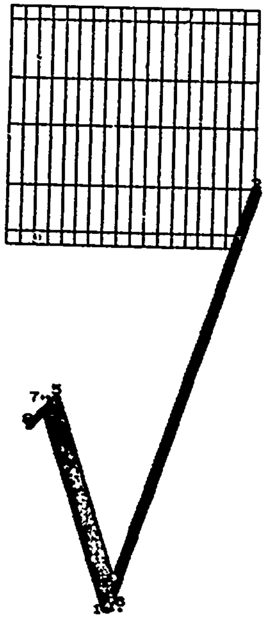
```
% Set intersection signs
charlist '124, '134;
subroutine bigin(var code, var units, var size, var depth)·
call charbegin(code, units, 0, 0, 0, depth, 0);
new w_19;   w_19 = round size;
cpen;   lft_19 x_1 = round u;   x_2 = x_1,   x_3 = r − x_3;   x_4 = x_5 = r − x_1;
top_19 y_3 = 0;   bot_19 y_1 = 1 − round depth·pixels;
y_2 = y_4 = 2/3[y_1, y_3];   y_5 = y_1;
call qcirc(3, 6, 2, size);   call qcirc(3, 7, 4, size);                  % cap
size draw 1..2;   draw 4..5.                                            % stems

"12 point set intersection sign";
call bigin('124, 15, w_1, 10pt).

"18 point set intersection sign",
call bigin('134, 20, w_3 + deltaw, 14pt);
call eighteen.

subroutine bigin:   .                          % free up METAFONT's memory

% Multiset union signs
charlis' '125, '135;
subroutine bigmun(var code, var units, var size, var depth):
call charbegin(code, units, 0, 0, 0, depth, 0);
new w_19;   w_19 = round size;
cpen;   lft_19 x_1 = round u;   x_2 = x_1;   x_3 = r − x_3;   x_4 = x_5 = r − x_1;
top_19 y_1 = 0;   bot_19 y_3 = 1 − round depth·pixels;
y_2 = y_4 = 2/3[y_1, y_3];   y_5 = y_1;
call qcirc(3, 6, 2, size);   call qcirc(3, 7, 4, size);                  % cup
size draw 1..2;   draw 4..5;                                            % stems
y_8 = y_9 = .47[y_1, y_3];   x_8 = r − x_9 = x_1 + 1.75size − eps,
x_10 = x_11 = x_3;   5[y_10, y_11] = y_8;   y_11 − y_10 = x_9 − x_8;
draw 8..9;   draw 10..11.                                      % enclosed plus sign

"12 point multiset union sign";
call bigmun('125, 15, w_1, 10pt).

"18 point multiset union sign";
call bigmun('135, 20, w_3 + deltaw, 14pt);
call eighteen.

subroutine bigmun:   .                         % free up METAFONT's memory
```

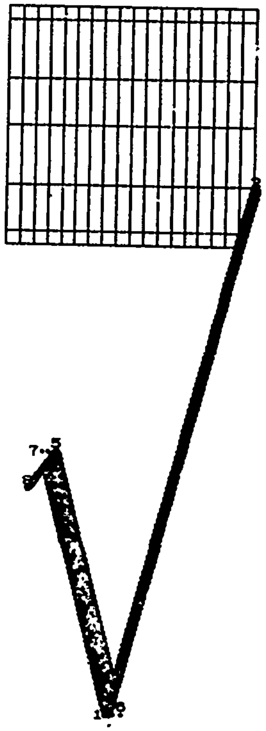


```
% Lattice infimum (logical AND) signs
charlist '126, '136;
subroutine bigmeet(var code, var units, var size, var depth):
call charbegin(code, units, 0, 0, 0, depth, 0);
new w19;   w19 = round size,
cpen;   lft19 x1 = round u;   x3 = r - x1;   x5 = r - x1;
top49 y1 = 0;   bot19 y1 = 1 - round depth·pixels - o;
y5 = y1,
size draw 1. 3;   draw 3..5.                                % diagonals

"12 point lattice meet sign";
call bigmeet('126, 15, w1, 10pt).

"18 point lattice meet sign";
call bigmeet('136, 20, w3 + deltaw, 14pt);
call eighteen.

subroutine bigmeet:  .                                  % free up METAFONT's memory

% Lattice supremum (logical OR) signs
charlist '127, '137;
subroutine bigjoin(var code, var units, var size, var depth)·
call charbegin(code, units, 0, 0, 0, depth, 0),
new w19,   w19 = round size;
cpen;   lft19 x1 = round u;   x3 = r - x1;   x5 = r - x1;
top19 y3 = o;   bot19 y1 = 1 - round depth·pixels;
y5 = y1;
size draw 1..3,   draw 3..5                                 % diagonals

"12 point lattice join sign";
call bigjoin('127, 15, w1, 10pt).

"18 point lattice join sign";
call bigjoin('137, 20, w3 + deltaw, 14pt),
call eighteen.

subroutine bigjoin:  .                                  % free up METAFONT's memory
```

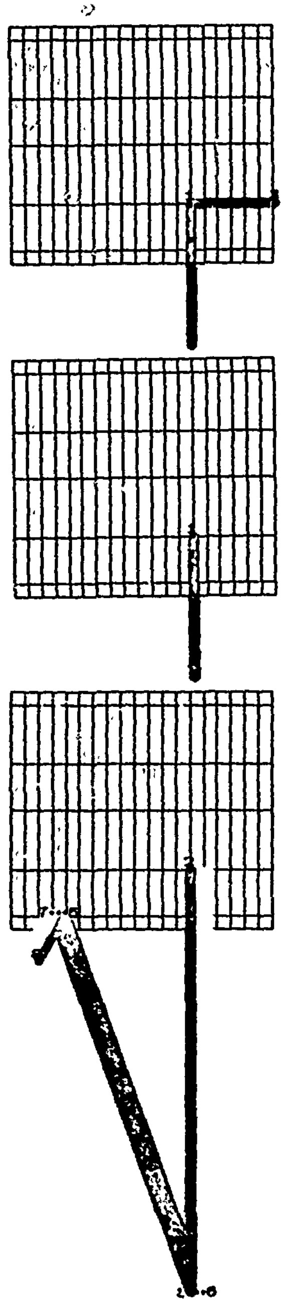


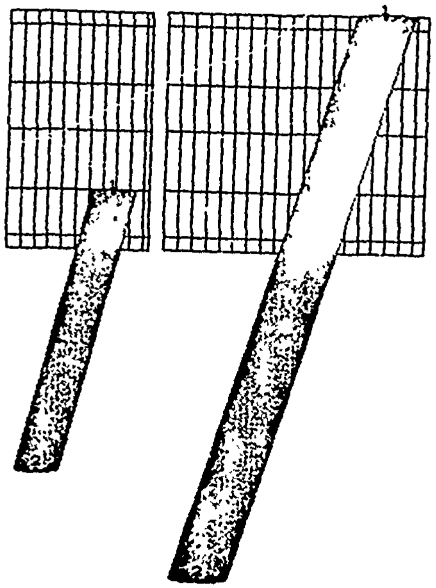






```
% Square root signs
charlist '160, '161, '162, '163, '164. 0;
subroutine bigroot(var code, var units, var height, var depth):
call charbegin(code, units, 0, 0, height, depth, 0);
hpen;   x1 = good10(8/18 r);   x2 = r + 1;   bot10y1 = 1 − round depth·pixels;
top10y2 = 0;
y3 = y5 = y7 = good6(.5[y1, y2]),   y4 = y6 = y1;
x7 = 1.5[x2, x1];   lft10x7 = lft2x3;   rt2x3 = rt0x5;
lft10x4 = lft2x4;   rt2x4 = rt0x6;
x8 = x7 − u;   new aa;   x8 = aa[x5, x2];   y8 = aa[y5, y2];
hpen;   w2 draw 3..4;                                        % left diagonal
w10 draw 7..4;   w0 draw 5 .6;                         % sharpen the corners
lpen#;   w2 draw 8..5;                            % erase excess at upper left
hpen,   w0 draw 8..5;                                                % serif
rpen#;   w2 draw 1. 2;                            % erase excess at lower right
hpen;   w10 draw 1..2.                                      % right diagonal

"12 point radical sign";
call bigroot('160, 18, 0, 12pt).

"18 point radical sign";
call bigroot('161, 18, 0, 18pt);
call eighteen.

"24 point radical sign";
call bigroot('162, 18, ph + pb, 24pt − ph − pb);
call twentyfour.

"30 point radical sign";
call bigroot('163, 18, ph + pb, 30pt − ph − pb);
call thirty.

subroutine bigroot: .                          % free up METAFONT's memory
```

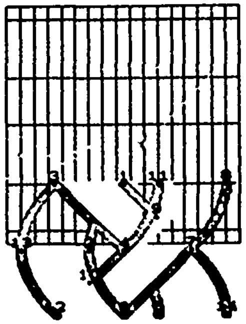


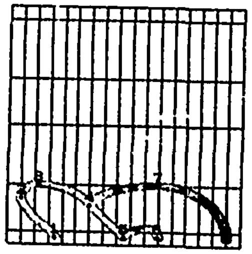


```
"Extensible radical sign-bottom";
call charbegin('164, 19, 0, 0, 0, 18pt, 0);
varchar '166, 0, '164, '166;                                  % extensible radical sign
hpen;  $x_1 = x_2 = \mathrm{good}_{10}(r - 6u)$;  $y_2 = 0$;  $\mathrm{bot}_{10} y_1 = \mathrm{round}(.5 - 18pt \cdot pixels)$;
$y_3 = y_5 = y_7 = \mathrm{good}_0(\,1[y_2, y_1])$;  $y_4 = y_6 = y_1$;
$x_7 = 3u$;  $\mathrm{lft}_{10} x_7 = \mathrm{lft}_2 x_3$;  $\mathrm{rt}_2 x_3 = \mathrm{rt}_0 x_5$;
$\mathrm{lft}_{10} x_1 = \mathrm{lft}_2 x_4$;  $\mathrm{rt}_2 x_4 = \mathrm{rt}_0 x_6$;
$x_8 = x_7 - u$;  new aa;  $x_8 = aa[x_5, x_2]$,  $y_8 = aa[y_5, h + b]$;
hpen;  $w_2$ draw 3  4;                                               % left diagonal
$w_{10}$ draw 7..4;  $w_0$ draw 5. 6;                                % sharpen the corners
lpen#;  $w_2$ draw 8..5;                                 % erase excess at upper left
hpen;  $w_0$ draw 8 .5;                                                       % serif
rpen#;  $w_2$ draw 1 .2;                                % erase excess at lower right
hpen;  $w_{10}$ draw 1  2.                                           % right diagonal

"Extensible radical sign-top",
call charbegin('166, 19, 0, 0, 0, 6pt, 0);
cpen;  $x_1 = x_2 = \mathrm{good}_{10}(r - 6u)$;  $x_3 = r + 1$;
$y_1 = y_3 = 0$;  $y_2 = \mathrm{round}(.5 - 6pt \cdot pixels)$;
$w_{10}$ draw 3..1..1. 2.                                           % link and stem

"Extensible radical sign-extension module";
call charbegin('165, 19, 0, 0, 0, 6pt, 0),
cpen;  $x_1 = x_2 = \mathrm{good}_{10}(r - 6u)$;  $y_1 = 0$;  $y_2 = \mathrm{round}(5 - 6pt \cdot pixels)$;
$w_{10}$ draw 1..2.                                                          % stem
```

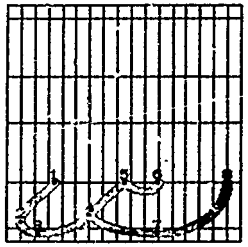
The file mexext mf

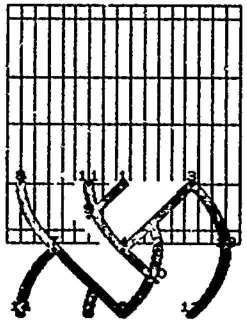
```
% Extrabold slashes
charlist '017, '037;
"12 point extrabold slash";
call bigslash('017, 10 4, bold + 6deltaw, 0, 12pt).

"24 point extrabold slash";
call bigslash('037, 18 8, bold + 10deltaw, ph + pb, 24pt - ph - pb);
call twentyfour.
```



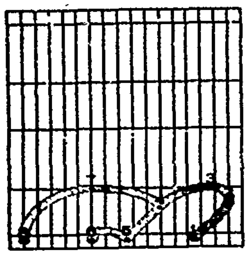


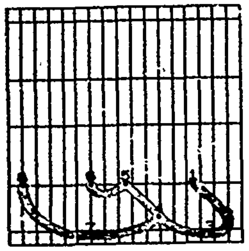
```
% Left pretzels (left-right symmetric with respect to right ones)
"Extensible left pretzel-extension module";
call charbegin('056, 17, u, 0, 0, 50/9 pt, 0);
varchar '144, 0, '146, '056;                                             % the left pretzel
hpen;  x13 = good10 u;  x3 = x12 = 3.5u;  x2 = good10 6u;  x1 = x4 = x6 = 8.5u;
x11 = x5 = good10 11u;  x7 = 13.5u;  x8 = x14 = good10 16u;
y1 = y3 = y8 = y11 = 0;
y4 = −25/9 pt·pixels;  y7 = y6 + 25/9 pt·pixels;  y2 = y13 = .5[y3, y12];
y5 = y6 = y12 = y14 = round(.5 − 50/9 pt pixels);
x9 = 11u;  y9 = −25/18 pt·pixels;
x10 = 6u;  y10 = y12 + 25/18 pt·pixels;
w10 draw 1{x6 − x7, y6 − y7}..2{0, −1};                    % right of upper left strand
rpen#;  u ddraw 3..4, 1..4;                       % erase part covered by upper middle strand
hpen;  w10 draw 4{x1 − x3, y1 − y3}..5{0, −1};              % left of lower right strand
lpen#;  u ddraw 6..7, 6..4;                       % erase part covered by lower middle strand
hpen;  w10 draw 3..4;                                          % left of upper middle strand
draw 6..7{x7 − x6, y7 − y6}..8{0, 1};            % right of lower middle/upper right strand
draw 1..9;                                                    % right of upper middle strand
rpen#;  u ddraw 4{x1 − x10, y1 − y10}..11{0, 1},
    9..11;                                         % erase part covered by upper right strand
hpen;  w10 draw 10..
    4{x1 − x10, y1 − y10}..11{0, 1};              % left of upper right/lower middle strand
lpen#;  u ddraw 2{0, −1}..6{x9 − x1, y9 − y1},
    2..10;                                          % erase part covered by lower left strand
hpen;  w10 draw 12{x3 − x4, y3 − y4}..
    13{0, 1}..3{x10 − x12, y10 − y12};                % left of lower left/upper left strand
draw 2{0, −1}..6{x9 − x1, y9 − y1};                           % right of lower left strand
draw 7{x7 − x9, y7 − y9}..14{0, −1}.             % right of upper middle/lower right strand

"Extensible left pretzel-top";
call charbegin('144, 17, 0, 0, 0, 25/9 pt, 0);
hpen;  x1 = 3.5u;  y1 = y5 = y6 = y8 = round(.5 − 20/9 pt pixels);
x2 = good10 u;  y2 = 1/3[y1, y4];
x3 = .5[x1, x2];  y3 = y7 = good0 0;
x4 = 6u;  y4 = y5 + 25/18 pt pixels;
x5 = 8.5u;  x6 = x7 = 11u;  x8 = good10 16u;
w10 draw 1{x1 − x5, y1 − y5}..2{0, 1}..3{1, 0}..
    4{x5 − x1, y5 − y4}..5;                                                   % end piece
draw 5{x5 − x4, y4 − y5}..6{0, −1};                                     % bottom of twist
draw 4{x5 − x1, y4 − y5}..7{1, 0}..8{0, −1}.                               % top of twist
```

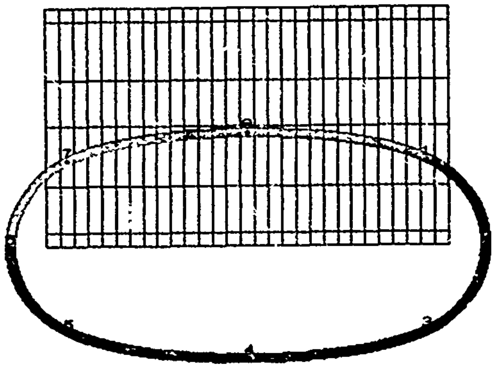


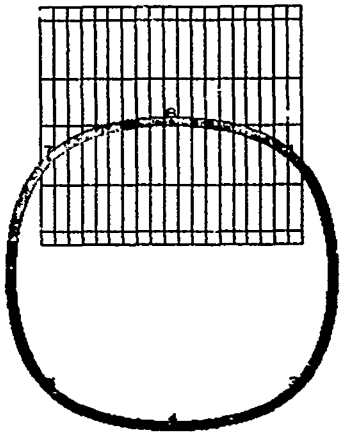


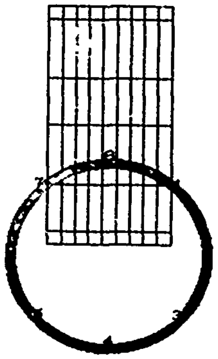
```
'Extensible left pretzel-bottom";
call charbegin('146, 17, 0, 0, 0, 23/9 pt, 0);
hpen;   x1 = 3.5u;   y1 = y5 = y6 = y8 = 0;
x2 = good10 u;   y2 = 1/4[y3, y1];
x3 = 5[x1, x4];   y3 = y7 = good8(.5 − 20/9 pt·pixels);
x4 = 6u;   y4 = y5 − 23/18 pt·pixels;
x5 = 3.5u,   x6 = x7 = 11u;   x8 = good10 16u;
w10 draw 1{x1 − x5, y4 − y5}..2{0, −1}. 3{1,0}..
     4{x5 − x1, y5 − y4}..5;                                   % end piece
draw 5{x5 − x1, y4 − y5}. 6{0, 1};                             % top of twist
draw 4{x5 − x1, y4 − y5}..7{1, 0}..8{0, 1}.                    % bottom of twist

% Right pretzels (left-right symmetric with respect to left ones)
"Extensible right pretzel-extension module";
call charbegin('057, 17, 0, 0, 0, 50/9 pt, 0),
varchar '145, 0, '147, '057;                                   % the right pretzel
hpen;   r − x13 = good10 u:   r − x3 = r − x12 = 3 5u,   r − x2 = good10 6u,   x1 = x4 =
x6 = r − 8.5u;
x11 = x5 = r − good10 11u;   r − x7 = 13.5u,   x8 = x14 = r − good10 16u;
y1 = y3 = y8 = y11 = 0;
y4 = −23/9 pt·pixels;   y7 = y6 + 23/9 pt pixels;   y2 = y13 = .5[y3, y12];
y5 = y6 = y12 = y14 = round(.5 − 20/9 pt·pixels);
r − x9 = 11u;   y9 = −23/18 pt·pixels;
r − x10 = 6u;   y10 = y12 + 23/18 pt·pixels;
w10 draw 1{x6 − x7, y6 − y7}. 2{0, −1};                        % left of upper right strand
lpen‡,   u ddraw 3..4, 1..4;                   % erase part covered by upper middle strand
hpen;   w10 draw 4{x4 −− x3, y4 − y3}. 5{0, −1};               % right of lower left strand
lpen‡;   u ddraw 6..7, 6..4;                   % erase part covered by lower middle strand
hpen;   w10 draw "   4;                                        % right of upper middle strand
draw 6..7{x7 − x.., y7 − y6}..8{0, 1};               % left of lower middle/upper left strand
draw 1..9;                                                     % left of upper middle strand
lpen‡;   u ddraw 4{x4 − x10, y4 − y10}  .11{0, 1},
     9. 11;                                    % erase part covered by upper left strand
hpen;   w10 draw 10..
     4{x4 − x10, y4 − y10}..11{0, 1};          % right of upper left/lower middle strand
rpen‡;   u ddraw 2{0, −1}..6{x9 − x1, y9 − y1},
     2..10;                                    % erase part covered by lower right strand
hpen;   w10 draw 12{x1 − x1, y3 − y1}
     13{0, 1}..3{x10 − x12, y10 − y12};        % right of lower right/upper right strand
draw 2{0, −1}   6{x9 − x1, y9 − y1};                           % left of lower right strand
draw 7{x7 − x9, y7 − y9}..14{0, −1}.           % left of upper middle/lower left strand
```





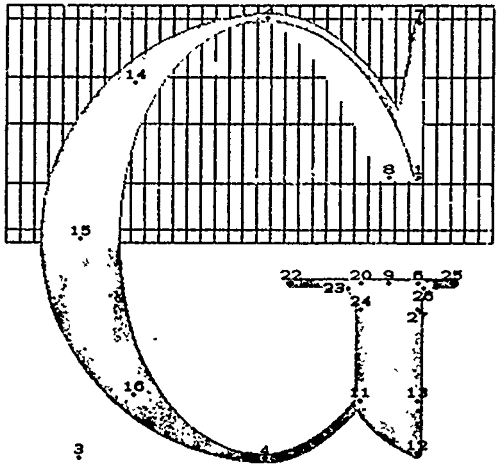




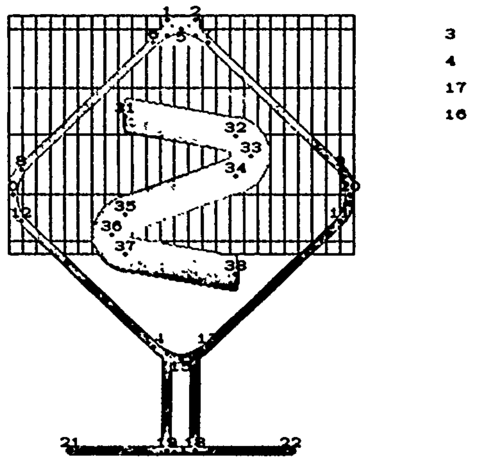


```
"Extensible right pretzel-top";
call charbegin('145, 17, 0, 0, 0, 25/9 pt, 0);
hpen;   r − x1 = 3.5u;   y1 = y5 = y6 = y8 = round(.5 − 20/9 pt pixels);
r − x2 = good10 u;   y2 = 1/4[y5, y1];
x3 = .5[x1, x2];   y3 = y7 = good6 0;
r − x4 = 6u;   y4 = y5 + 25/18 pt·pixels;
r − x5 = 8.5u;   r − x6 = r − x7 = 11u;   r − x8 = good10 16u;
w10 draw 1{x4 − x5, y4 − y5} . . 2{0, 1} . . 3{−1, 0} . .
      4{x5 − x4, y5 − y4} . . 5;                                    % end piece
draw 5{x5 − x4, y4 − y5} . . 6{0, −1};                            % bottom of twist
draw 4{x5 − x4, y4 − y5} . . 7{−1, 0} . . 8{0, −1}.                  % top of twist

"Extensible right pretzel-bottom";
call charbegin('147, 17, 0, 0, 0, 25/9 pt, 0);
hpen;   r − x1 = 3.5u;   y1 = y5 = y6 = y8 = 0;
r − x2 = good10 u;   y2 = 1/4[y5, y1];
x3 = .5[x1, x2];   y3 = y7 = good6(.5 − 20/9 pt pixels);
r − x4 = 6u;   y4 = y5 − 25/18 pt·pixels;
r − x5 = 8.5u;   r − x6 = r − x7 = 11u;   r − x8 = good10 16u;
w10 draw 1{x4 − x5, y4 − y5} . . 2{0, −1} . . 3{−1, 0} . .
      4{x5 − x4, y5 − y4} . . 5;                                    % end piece
draw 5{x5 − x4, y4 − y5} . . 6{0, 1};                              % top of twist
draw 4{x5 − x4, y4 − y5} . . 7{−1, 0} . . 8{0, 1}.                   % bottom of twist

% Circumscribed circles
subroutine bigcircle(var code, var units, var depth, var asp).
call charbegin(code, units, 0, 0, 0, depth, 0);
new aa;   aa = .5 sqrt(r·r + depth·depth pixels·pixels/asp/asp);
x8 = .5r;   y2 = −.5 round depth·pixels;
x2 = good10(x8 + aa);   y8 = good10(y2 + asp aa);
call circle(1, 2, 3, 4, 5, 6, 7, 8, w10).                                % bowl

new sqrtsave;   sqrtsave = sqrttwo;
"Ellipse for floating-point mod operator";
new sqrttwo;   sqrttwo = 1.3195;
call bigcircle('140, 29, 5pt, .5).

"Circle to enclose two digits";
call bigcircle('141, 19, 7.5pt, 1).

"Circle to enclose an exponent of 2";
new sqrttwo;   sqrttwo = sqrtsave;
call bigcircle('142, 9, 6pt, 1).
```

63



```
"Large G for user manuals";
call charbegin('176, 35, 0, 0, ph, 0, 0)·
% The depth of this character has been intentionally set to zero.
new w97, w98, w99;
w97 = round(1.5pw·pixels + blacker);
w98 = round(3pwiv pixels + blacker);
w99 = round(3pwv·pixels + blacker);
cpen;   rt97x1 = rt98x9 = round(12/11 r),   lft99x3 = round r/14;
x2 = x4 = 7.5/11 r;   top97y2 = h + 2o;   bot97y4 = 1 − round(12pt·pixels − 2o);
y3 = y4;   y5 = .6[y2, y1];   y1 = good6 9/25[y2, y3];
x6 = x1;   y9 = good97 3/5[y2, y3];
x7 = x1;   top97y7 = h;   lft97x8 = lft98x1;   y8 = y1;
hpen;   w97 ddraw 1..7, 8..7,                                       % upper serif
lpen#;   w97 ddraw (6   )1..2{−1, 0},
     (6..)8..2{−1, 0};                                    % erase spurious part
cpen;   w97 draw (6..)1..2{−1, 0};                             % upper right stroke
x15 = x3,   y15 = 5[y2, y3];
call hcirc(2, 14, 15, 16, 17, w97);                         % reinforce main stroke
call ˋa darc(2, 3, w99);                                             % main stroke
crsbreak .5[y2, y3];
y11 = y10 = y13 = 1/3[y3, y9];
lft97x11 == lft98x9;   rt97x12 = rt97x13 == rt98x9;   y12 = y3 + 2o;
w97 draw 4{1, 0}..11.  9{0, 1};                              % lower right stroke
x20 = x11,   y20 = y9;   x21 = x12;   y21 = y9;
ddraw 20..11, 21..13;                                                      % stem
ddraw 13..12, 11{0, −1}..12{2(x12 − x11), y12 − y11};                       % spur
y22 = y25 == y20;   y24 = y27 = y20 − 2s;
y23 = y26 = 1/3[y20, 1/2[y22, y24]];
x22 = x20 − 2/11 r;   x24 = x20;   x23 = 1/3[x20, 1/2[x22, x24]];
x25 = x21 + r/14;   x27 = x21;   x26 = 1/3[x21, 1/2[x27, x25]];
minvr 0;   minvs 0;
ddraw 22{1, 0}..23..24{0, −1}, 25{−1, 0}..26   27{0, −1},               % lower serif
minvr 0 5;   minvs 0.5.
```



```
"Dangerous bend sign";
call charbegin('177, 25, 0, 0, ph + pb, 0, 0);
% The depth of this character has been intentionally set to zero.
% The actual depth is 11pt, as desired in the user manuals.
minvr 0;  minvs 0;
cpen;  $x_1 = \mathrm{good}_{10}(.5r - u) = r - x_2$;                       % left-right symmetry;
$\mathrm{top}_{10} y_1 = h + b$;  $y_2 = y_1$;
$x_3 = x_1$;  $x_4 = x_2$;  $x_5 = r - x_5$;  $x_6 = r - x_7$;  $x_8 = r - x_9$;  $x_0 = r - x_{20}$;
$x_6 = x_5 - 2u$;  $x_8 = u$;  $\mathrm{lft}_{10} x_0 = 0$;
$y_5 = \mathrm{good}_{10}(\frac{25}{27}(h + b))$;  $y_6 = y_7 = \frac{23}{27}(h + b)$;  $y_8 = y_9 = \frac{1}{27}(h + b)$;  $y_0 = y_{20} = 0$;
$y_{11} + y_9 = y_{12} + y_8 = y_{13} + y_7 = y_{14} + y_6 =$
    $y_{15} + y_5 = y_{16} + y_1 = y_{17} + y_3 = 0$;                          % top-bottom symmetry
$x_{11} - x_9 = x_{12} - x_8 = x_{13} - x_7 = x_{14} - x_6 = x_{15} - x_5 =$
    $x_{16} - x_4 = x_{17} - x_3 = x_{18} - x_2 = x_{19} - x_1 = 0$;
$y_{18} = y_{19} = y_{21} = y_{22}$;  $\mathrm{bot}_{10} y_{21} = 1 - \mathrm{round}(11pt \cdot pixels)$;
$x_{21} = r - x_{22} = \mathrm{good}_{10}(.5r - 8u)$;
$y_3 = y_4 = .5[y_5, y_6]$;
$w_{10}$ draw 1..2;                                                            % top of signpost
draw 21..22;                                                                   % ground level
draw 1..3;  draw 19..17;                                                 % left edge of signpost
draw 2..4;  draw 18..16;                                                % right edge of signpost
rpen#;  draw |1|5{-1,0}..|2u|6{$x_8 - x_6, y_8 - y_6$};
    draw |1|15{-1,0}..|2u|14{$x_{12} - x_{14}, y_{12} - y_{14}$};         % erase hidden left edge
lpen#;  draw |1|5{1,0}..|2u|7{$x_9 - x_7, y_9 - y_7$};
    draw |1|15{1,0}..|2u|13{$x_{11} - x_{13}, y_{11} - y_{13}$};          % erase hidden right edge
cpen,  $w_{10}$ draw 5{-1,0}..6{$x_8 - x_6, y_8 - y_6$}..
    8{$x_8 - x_6, y_8 - y_6$}..0{0,-1};                                  % upper left edge of sign
draw 5{1,0}..7{$x_9 - x_7, y_9 - y_7$}..
    9{$x_9 - x_7, y_9 - y_7$}..20{0,-1};                                % upper right edge of sign
draw 15{-1,0}..14{$x_{12} - x_{14}, y_{12} - y_{14}$}..
    12{$x_{12} - x_{14}, y_{12} - y_{14}$}..0{0,1};                        % lower left edge of sign
draw 15{1,0}..13{$x_{11} - x_{13}, y_{11} - y_{13}$}..
    11{$x_{11} - x_{13}, y_{11} - y_{13}$}..20{0,1};                      % lower right edge of sign
new $w_{99}$;  $w_{99} = \mathrm{round}(bold + 4deltaw)$;
$x_{31} = r - x_{38} = x_5 - 4u$,  $x_{32} = x_{34} = x_{38}$;
$x_{35} = x_{37} = x_{31}$;  $x_{33} = r - x_{36} = \mathrm{good}_{99}(x_5 + 5u)$;
$y_{31} = \frac{13}{27}(h + b)$;  $y_{32} = \frac{9}{27}(h + b)$;  $y_{33} = \frac{6}{27}(h + b)$;  $y_{34} = \frac{1}{27}(h + b)$;
$y_{31} + y_{38} = y_{32} + y_{37} = y_{33} + y_{36} = y_{34} + y_{35} = 0$;
vpen;  $w_{99}$ draw 31..32;                                                           % upper bar
draw 38..37;                                                                           % lower bar
cpen;  $w_{99}$ draw 32{$x_{32} - x_{31}, y_{32} - y_{31}$}..33{0,-1}..
    34{$x_{35} - x_{34}, y_{35} - y_{34}$}..35{$x_{35} - x_{34}, y_{35} - y_{34}$}..36{0,-1}..
    37{$x_{38} - x_{37}, y_{38} - y_{37}$};                                  % the dangerous bend
crsbreak 0;
minvr .5;  minvs .5.
```

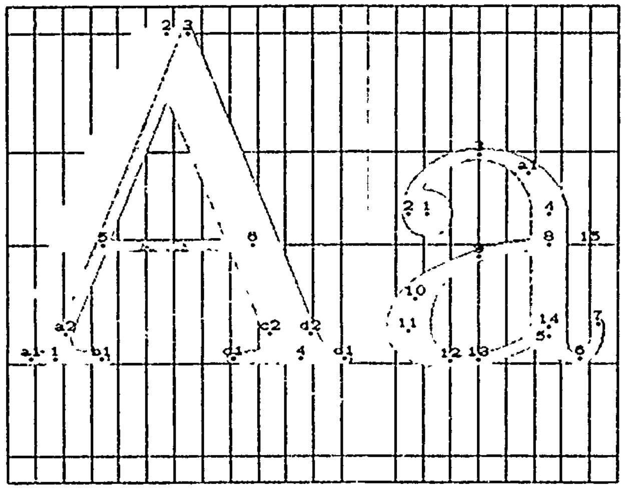
	0	1	2	3	4	5	6	7
'000	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ
'010	Φ	Ψ	Ω	ı	ȷ	`	´	ˆ
'020	ˇ	˘	¯	¨	˜	ˉ	˙	•
'030	¸	ˏ	ˆ	ß	æ	œ	Æ	Œ
'040	ø	!	"	'	∞	%	&	'
'050	(	)	*	+	,	-	.	/
'060	0	1	2	3	4	5	6	7
'070	8	9	:	;	<	=	>	?
'100	Ø	A	B	C	D	E	F	G
'110	H	I	J	K	L	M	N	O
'120	P	Q	R	S	T	U	V	W
'130	X	Y	Z	[	“	]	–	—
'140	‘	a	b	c	d	e	f	g
'150	h	i	j	k	l	m	n	o
'160	p	q	r	s	t	u	v	w
'170	x	y	z	ff	fi	fl	ffi	ffl

Mathematics books and journals do not look as beautiful as they used to. It is not that their mathematical content is unsatisfactory, rather that the old and well developed traditions of typesetting have become too expensive. Fortunately, it now appears that mathematics itself can be used to solve this problem, in spite of the fact that the first edition of Æsop's Œuvres is naïve about the efficient preparation of flawless soufflés. This is a sample of the font when the resolution is 200 dots per inch and 3.6 dots per "point".

STANDARD FONTS

The file cmr10.mf

```
"Computer Modern Roman 10 point";
ph = 250/36;   px = 160/36;   pe = 90/36;   pd = 70/36;
pb = 20/36;   po = 1/36;   ps = 20/36;   pa = .5(ph − pd);
pw = 9/36;   pwi = 27/36;   pwii = 32/36;   pwiii = 38/36;
pwiv = 32/36;   pwv = 38/36;   aspect = 1.0;
pu = 20/36;   lcs = 1.075;   ucs = 1.7;   sc = 0;   ls = 0,
slant = 0;   sqrttwo = sqrt 2;   fixwidth = 0;
halfd = 0;   varg = 0;   lowast = 0;   ligs = 1.

input cmbase;   call fontbegin;
input roman;
end
```

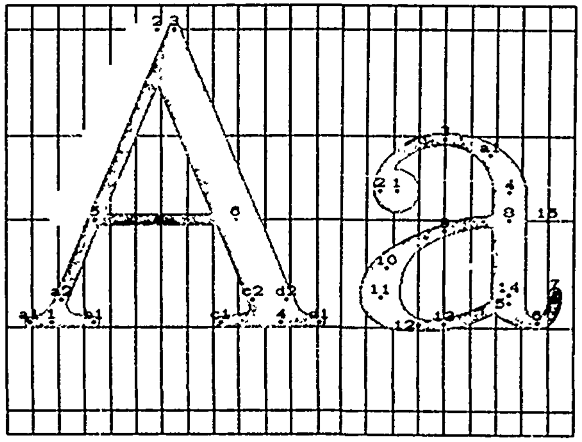


	0	1	2	3	4	5	6	7
´000	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ
´010	Φ	Ψ	Ω	ı	ȷ	`	´	ˆ
´020	ˇ	˘	-	¨	˜	˙	˝	•
´030	¸	˛	ˆ	ß	æ	œ	Æ	Œ
´040	ø	!	"	'	∞	%	&	'
´050	(	)	*	+	,	-	.	/
´060	0	1	2	3	4	5	6	7
´070	8	9	:	;	<	=	>	?
´100	Ø	A	B	C	D	E	F	G
´110	H	I	J	K	L	M	N	O
´120	P	Q	R	S	T	U	V	W
´130	X	Y	Z	[	“	]	–	—
´140	‘	a	b	c	d	e	f	g
´150	h	i	j	k	l	m	n	o
´160	p	q	r	s	t	u	v	w
´170	x	y	z	ff	fi	fl	ffi	ffl

Mathematics books and journals do not look as beautiful as they used to. It is not that their mathematical content is unsatisfactory, rather that the old and well developed traditions of typesetting have become too expensive. Fortunately, it now appears that mathematics itself can be used to solve this problem, in spite of the fact that the first edition of Æsop's Œuvres is naïve about the efficient preparation of flawless soufflés. This is a sample of the font when the resolution is 200 dots per inch and 3.6 dots per "point".

The file cmr9.mf

```
"Computer Modern Roman 9 point",
ph = 225/36;   px = 144/36;   pe = 81/36;   pd = 63/36;
pb = 18/36;   po = 4/36;   ps = 18/36;   pa = .5(ph − pd);
pw = 9/36;   pwi = 25/36;   pwii = 29/36;   pwiii = 33/36;
pwiv = 29/36;   pwv = 33/36;   aspect = 1.0;
pu = 18.5/36,   lcs = 1.05;   ucs = 1.65;   sc = 0;   ls = 0;
slant = 0;   sqrttwo = sqrt 2;   fixwidth = 0;
halfd = 0;   varg = 0;   lowast = 0:   ligs = 1.

input cmbase;   call fontbegin;
input roman;
end
```



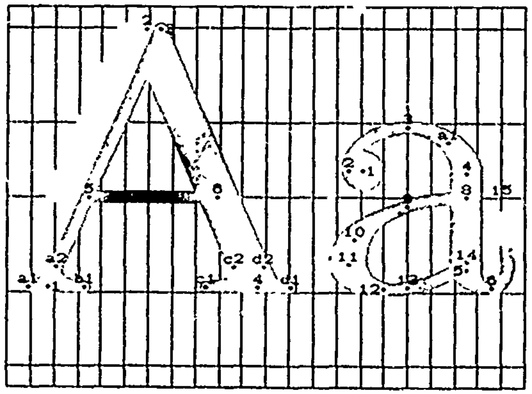
	0	1	2	3	4	5	6	7
'000	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ
'C10	Φ	Ψ	Ω	ı	ȷ	`	´	ˆ
'020	ˇ	˘	¯	¨	-	-	˙	•
'030	¸	ˏ	˜	ß	æ	œ	Æ	Œ
'040	ø	!	"	'	∞	%	&	'
'050	(	)	•	+	,	-	.	/
'060	0	1	2	3	4	5	6	7
'070	8	9	:	;	<	=	>	?
'100	ø	A	B	C	D	E	F	G
'110	H	I	J	K	L	M	N	O
'120	P	Q	R	S	T	U	V	W
'130	X	Y	Z	[	"	]	-	—
'140	'	a	b	c	d	e	f	g
'150	h	i	j	k	l	m	n	o
'160	p	q	r	s	t	u	v	w
'170	x	y	z	ff	fi	fl	ffi	ffl

Mathematics books and journals do not look as beautiful as they used to. It is not that their mathematical content is unsatisfactory, rather that the old and well developed traditions of typesetting have become too expensive. Fortunately, it now appears that mathematics itself can be used to solve this problem, in spite of the fact that the first édition of Æsop's Œuvres is naïve about the efficient preparation of flawless soufflés. This is a sample of the font when the resolution is 200 dots per inch and 3.6 dots per "point".

The file cmr8.mf

"Computer Modern Roman 8 point";
$ph = \frac{200}{36}$; $px =: \frac{128}{36}$; $pe = \frac{72}{36}$; $pd = \frac{56}{36}$;
$pb = \frac{10}{36}$; $po = \frac{3}{36}$; $ps = \frac{18}{36}$; $pa = .5(ph - pd)$;
$pw = \frac{9}{36}$; $pwi = \frac{21}{30}$; $pwii = \frac{27}{36}$; $pwiii = \frac{30}{36}$;
$pwiv = \frac{27}{36}$; $pwv = \frac{30}{36}$; $aspect = 1.0$;
$pu = \frac{17}{36}$; $lcs = 1.03$; $ucs = 1.56$; $sc = 0$; $ls = 0$;
$slant = 0$; $sqrttwo = \mathrm{sqrt}\,2$; $fixwidth = 0$;
$halfd = 0$; $varg = 0$; $lowast = 0$; $ligs = 1$.

input cmbase; call *fontbegin*;
input roman;
end



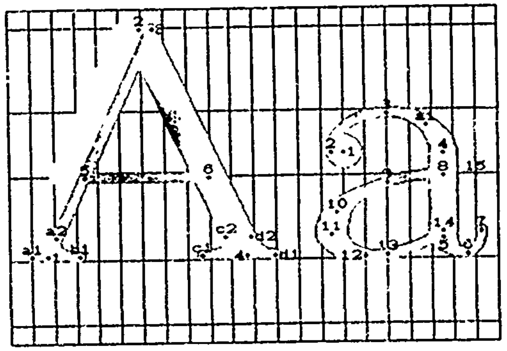
	0	1	2	3	4	5	6	7
'000	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ
'010	Φ	Ψ	Ω	ı	ȷ	`	´	ˇ
'020	˙	˘	¯	-	-	-	-	·
'030	¸	,	ˆ	ß	æ	œ	Æ	Œ
'040	ø	!	"	’	∞	%	&	'
'050	(	)	*	+	,	-	.	/
'060	0	1	2	3	4	5	6	7
'070	8	9	:	;	<	=	>	?
'100	Ø	A	B	C	D	E	F	G
'110	H	I	J	K	L	M	N	O
'120	P	Q	R	S	T	U	V	W
'130	X	Y	Z	[	"	]	–	—
'140	'	a	b	c	d	e	f	g
'150	h	i	j	k	l	m	n	o
'160	p	q	r	s	t	u	v	w
'170	x	y	z	ff	fi	fl	ffi	ffl

Mathematics books and journals do not look as beautiful as they used to. It is not that their mathematical content is unsatisfactory, rather that the old and well developed traditions of typesetting have become too expensive. Fortunately, it now appears that mathematics itself can be used to solve this problem, in spite of the fact that the first edition of Æsop's Œuvres is naïve about the efficient preparation of flawless soufflés. This is a sample of the font when the resolution is 200 dots per inch and 3.6 dots per "point".

The file cmr7.mf

"Computer Modern Roman 7 point";
$ph = \frac{175}{36}$; $px = \frac{112}{36}$; $pe = \frac{93}{36}$; $pd = \frac{49}{36}$;
$pb = \frac{14}{36}$; $po = \frac{3}{36}$; $ps = \frac{11}{36}$; $pa = 5(ph - pd)$;
$pw = \frac{8}{36}$; $pwi = \frac{21}{36}$; $pwii = \frac{24}{36}$; $pwiii = \frac{29}{36}$;
$pwiv = \frac{24}{36}$; $pwv = \frac{28}{36}$; $aspect = 1.0$;
$pu = \frac{19}{36}$; $lcs = .97$; $ucs = 1.44$; $sc = 0$; $ls = 0$;
$slant = 0$; $sqrttwo = sqrt\,2$; $fixwidth = 0$;
$halfd = 0$; $varg = 0$; $lowast = 0$; $ligs = 1$.

input cmbase; call *fontbegin*;
input roman;
end

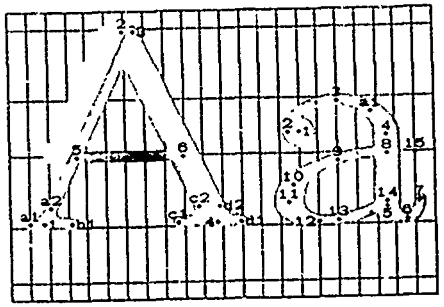


	0	1	2	3	4	5	6	7
'000	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ
'010	Φ	Ψ	Ω	ı	ȷ	`	´	˙
'020	[illegible]	[illegible]	-	-	-	-	[illegible]	[illegible]
'030	¸	´	ˉ	ß	æ	œ	Æ	Œ
'040	[illegible]	!	"	'	∞	%	&	'
'050	(	)	*	+	,	-	.	/
'060	0	1	2	3	4	5	6	7
'070	8	9	:	;	<	=	>	?
'100	@	A	B	C	D	E	F	G
'110	H	I	J	K	L	M	N	O
'120	P	Q	R	S	T	U	V	W
'130	X	Y	Z	[	"	]	–	—
'140	'	a	b	c	d	e	f	g
'150	h	i	j	k	l	m	n	o
'160	p	q	r	s	t	u	v	w
'170	x	y	z	ff	fi	fl	ffi	ffl

Mathematics books and journals do not look as beautiful as they used to. It is not that their mathematical content is unsatisfactory, rather that the o'd and well developed traditions of typesetting have become too expensive. Fortunately, it now appears that mathematics itself can be used to solve this problem, in spite of the fact that the first edition of Æsop's Œuvres is naïve about the efficient preparation of flawless soufflés. This is a sample of the font when the resolution is 200 dots per inch and 3.6 dots per "p:int".

"Computer Modern Roman 6 point";
$ph = \frac{150}{36}$; $px = \frac{90}{36}$; $pe = \frac{54}{36}$; $pd = \frac{42}{36}$;
$pb = \frac{12}{36}$; $po = \frac{2}{36}$; $ps = \frac{12}{36}$, $pa = .5(ph - pd)$;
$pw = \frac{8}{36}$; $pwi = \frac{10}{36}$; $pwii = \frac{22}{36}$; $pwiii = \frac{21}{36}$;
$pwiv = \frac{22}{36}$; $pwv = \frac{21}{36}$; $aspect = 1.0$;
$pu = \frac{14}{36}$; $lcs = 89$; $ucs = 1\,43$; $sc = 0$; $ls = 0$;
$sl^nt = 0$; $sqrttwo = \mathrm{sqrt}\,2$; $fixwidth = 0$;
$halfd = 0$; $varg = 0$; $lowast = 0$; $ligs = 1$.

input cmbase; call *fontbegin*;
input roman;
end



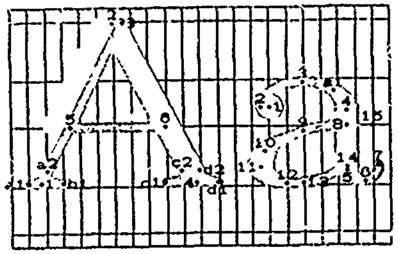
	0	1	2	3	4	5	6	7
´000	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ
´010	Φ	Ψ	Ω	ı	ȷ	[illegible]	[illegible]	[illegible]
´020	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
´030	[illegible]	[illegible]	[illegible]	ß	æ	œ	Æ	Œ
´040	[illegible]	!	[illegible]	[illegible]	[illegible]	%	&	'
´050	(	)	[illegible]	+	,	-	.	/
´060	0	1	2	3	4	5	6	7
´070	8	9	:	;	<	=	>	?
´100	@	A	B	C	D	E	F	G
´110	H	I	J	K	L	M	N	O
´120	P	Q	R	S	T	U	V	W
´130	X	Y	Z	[	“	]	–	—
´140	‘	a	b	c	d	e	f	g
´150	h	i	j	k	l	m	n	o
´160	p	q	r	s	t	u	v	w
´170	x	y	z	ff	fi	fl	ffi	ffl

Mathematics books and journals do not look as beautiful as they used to. It is not that their mathematical content is unsatisfactory, rather that the old and well developed traditions of typesetting have become too expensive. *Fortunately*, it now appears that mathematics itself can be used to solve this problem, in spite of the fact that the first edition of Æsop's Œuvres is naïve about the efficient preparation of flawless soufflés. This is a sample of the font when the resolution is 200 dots per inch and 2.8 dots per "point".

The file cmr5.mf

“Computer Modern Roman 5 point”;
$ph = \frac{125}{36}$; $px = \frac{80}{36}$; $pe = \frac{15}{36}$; $pd = \frac{35}{36}$;
$pb = \frac{10}{36}$; $po = \frac{2}{36}$; $ps = \frac{10}{36}$; $pa = .5(ph - pd)$;
$pw = \frac{7}{36}$; $pwi = \frac{17}{36}$; $pwii = \frac{19}{36}$; $pwiii = \frac{20}{36}$;
$pwiv = \frac{19}{36}$; $pwv = \frac{20}{36}$; $aspect = 1.0$;
$pu = \frac{12.5}{36}$; $lcs = .84$; $ucs = 1.32$; $sc = 0$; $ls = 0$;
$slant = 0$; $sqrttwo = \mathrm{sqrt}\,2$; $fixwidth = 0$;
$halfd = 0$; $varg = 0$; $lowast = 0$; $ligs = 1$.

input cmbase; call *fontbegin*;
input roman;
end



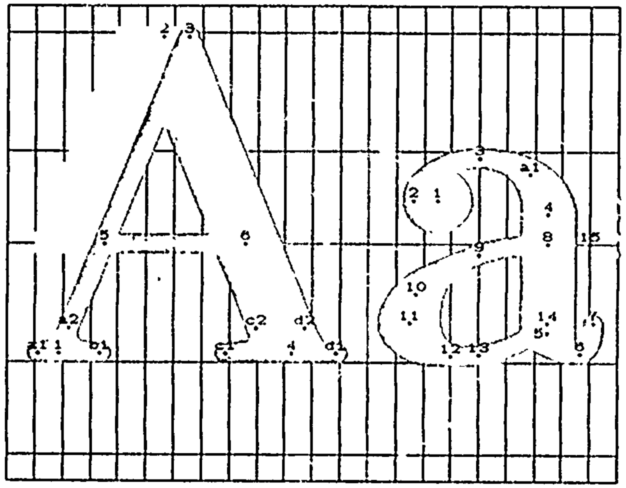
	0	1	2	3	4	5	6	7
'000	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ
'010	Φ	Ψ	Ω	ı	ȷ	`	´	ˆ
'020	ˇ	˘	¯	˝	¯	~	·	˚
'030	¸	,	ˆ	ß	æ	œ	Æ	Œ
'040	ø	!	"	'	∞	%	&	'
'050	(	)	*	+	,	-	.	/
'060	0	1	2	3	4	5	6	7
'070	8	9	:	;	<	=	>	?
'100	Ø	A	B	C	D	E	F	G
'110	H	I	J	K	L	M	N	O
'120	P	Q	R	S	T	U	V	W
'130	X	Y	Z	[	"	]	–	—
'140	'	a	b	c	d	e	f	g
'150	h	i	j	k	l	m	n	o
'160	p	q	r	s	t	u	v	w
'170	x	y	z	ff	fi	fl	ffi	ffl

Mathematics books and journals do not look as beautiful as they used to. It is not that their mathematical content is unsatisfactory, rather that the old and well developed traditions of typesetting have become too expensive. Fortunately, it now appears that mathematics itself can be used to solve this problem, in spite of the fact that the first edition of Æsop's Œuvres is naïve about the efficient preparation of flawless soufflés. This is a sample of the font when the resolution is 200 dots per inch and 3.6 dots per "point".

The file cmb10.mf

"Computer Modern Bold Roman 10 point";
ph = $\frac{250}{36}$;   *px* = $\frac{160}{36}$;   *pe* = $\frac{90}{36}$;   *pd* = $\frac{70}{36}$;
pb = $\frac{20}{36}$;   *po* = $\frac{5}{36}$;   *ps* = $\frac{20}{36}$;   *pa* = .5(*ph* − *pd*);
pw = $\frac{15}{36}$;   *pwi* = $\frac{30}{36}$;   *pwii* = $\frac{15}{36}$;   *pwiii* = $\frac{50}{36}$;
pwiv = $\frac{50}{36}$;   *pwv* = $\frac{20}{33}$;   *aspect* = 1.0;
pu = $\frac{20}{36}$,   *lcs* = 85;   *ucs* = 1.5;   *sc* = 0;   *ls* = 0;
slant = 0;   *sqrttwo* = 1.375;   *fixwidth* = 0;
halfd = 0;   *varg* = 0;   *lowast* = 0;   *ligs* = 1.

input cmbase;   call *fontbegin*;
input roman;
end

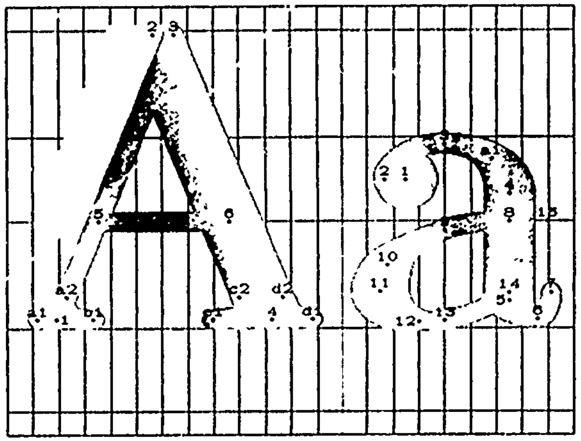


	0	1	2	3	4	5	6	7
'000	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ
'010	Φ	Ψ	Ω	ı	ȷ	`	´	ˆ
'020	ˇ	˘	¯	˜	¯	-	•	•
'030	¸	ˏ	˙	ß	æ	œ	Æ	Œ
'040	ø	!	”	'	∞	%	&	’
'050	(	)	*	+	,	-	.	/
'060	0	1	2	3	4	5	6	7
'070	8	9	:	;	<	=	>	?
'100	@	A	B	C	D	E	F	G
'110	H	I	J	K	L	M	N	O
'120	P	Q	R	S	T	U	V	W
'130	X	Y	Z	[	“	]	–	—
'140	‘	a	b	c	d	e	f	g
'150	h	i	j	k	l	m	n	o
'160	p	q	r	s	t	u	v	w
'170	x	y	z	ff	fi	fl	ffi	ffl

Mathematics books and journals do not look as beautiful as they used to. It is not that their mathematical content is unsatisfactory, rather that the old and well developed traditions of typesetting have become too expensive. Fortunately, it now appears that mathematics itself can be used to solve this problem, in spite of the fact that the first edition of Æsop's Œuvres is naïve about the efficient preparation of flawless soufflés. This is a sample of the font when the resolution is 200 dots per inch and 2.8 dots per "point".

The file cmb9 mf

```
"Computer Modern Bold Roman 9 point";
ph = $\frac{225}{36}$;   px = $\frac{111}{36}$,   pe = $\frac{81}{36}$;   pd = $\frac{93}{36}$;
pb = $\frac{18}{36}$;   po = $\frac{4}{36}$;   ps = $\frac{18}{36}$;   pa = .5(ph − pd);
pw = $\frac{15}{36}$;   pwi = $\frac{37}{36}$;   pwii = $\frac{42}{36}$;   pwiii = $\frac{40}{36}$;
pwiv = $\frac{40}{36}$;   pwv = $\frac{46}{36}$;   aspect = 1.0;
pu = $\frac{18.5}{36}$;   ι = .84;   ucs = 1.46;   sc = 0;   ls = 0;
slant = 0;   sqrttwo = 1.375;   fixwidth = 0;
halfd = 0;   varg = 0;   lowast = 0;   ligs = 1.

input cmbase;   call fontbegin;
input roman;
end
```



	0	1	2	3	4	5	6	7
'000	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ
'010	Φ	Ψ	Ω	ı	ȷ	`	´	˙
'020	˘	ˇ	¯	-	-	→	•	•
'030	¸	,	˚	ß	æ	œ	Æ	Œ
'040	ø	!	"	'	∞	%	&	'
'050	(	)	*	+	,	-	.	/
'060	0	1	2	3	4	5	6	7
'070	8	9	:	;	<	=	>	?
'100	[illegible]	A	B	C	D	E	F	G
'110	H	I	J	K	L	M	N	O
'120	P	Q	R	S	T	U	V	W
'130	X	Y	Z	[	"	]	-	—
'140	'	a	b	c	d	e	f	g
'150	h	i	j	k	l	m	n	o
'160	p	q	r	s	t	u	v	w
'170	x	y	z	ff	fi	fl	ffi	ffl

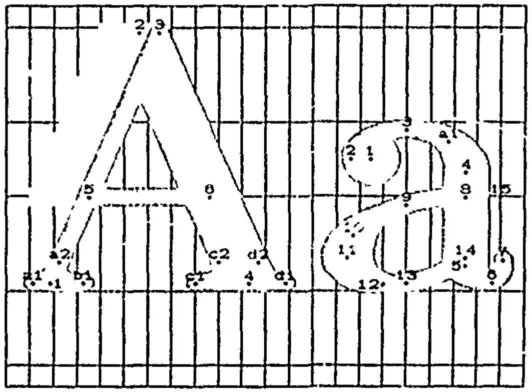
Mathematics books and journals do not look as beautiful as they used to. It is not that their mathematical content is unsatisfactory, rather that the old and well developed traditions of typesetting have become too expensive. Fortunately, it now appears that mathematics itself can be used to solve this problem, in spite of the fact that the first edition of Æsop's Œuvres is naïve about the efficient preparation of flawless soufflés. This is a sample of the font when the resolution is 200 dots per inch and 2.8 dots per "point".

The file cmb8.mf

"Computer Modern Bold Roman 8 point";

$ph = \frac{200}{36}$; $px = \frac{128}{36}$; $pe = \frac{72}{36}$, $pd = \frac{58}{36}$;
$pb = \frac{18}{36}$, $po = \frac{3}{36}$; $ps = \frac{18}{36}$; $pa = .5(ph - pd)$;
$pw = \frac{11}{36}$; $pwi = \frac{31}{36}$; $pwii = \frac{38}{36}$; $pwiii = \frac{12}{36}$;
$pwiv = \frac{12}{36}$; $pwv = \frac{42}{36}$; $aspect = 1.0$;
$pu = \frac{17}{36}$; $lcs = .82$; $ucs = 1.41$; $sc = 0$; $ls = 0$;
$slant = 0$; $sqrttwo = 1.375$; $fixwidth = 0$,
$halfd = 0$; $varg = 0$; $lowast = 0$; $ligs = 1$.

input cmbase; call *fontbegin*;
input roman;
end



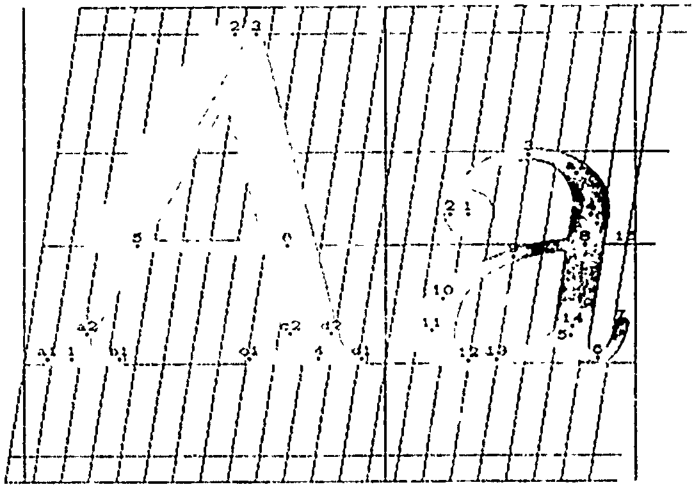
	0	1	2	3	4	5	6	7
'000	*Γ*	*Δ*	*Θ*	*Λ*	*Ξ*	*Π*	*Σ*	*Υ*
'010	*Φ*	*Ψ*	*Ω*	*ı*	*ȷ*	`	´	ˇ
'020	ˇ	˘	¯	¨	˜	ˉ	˝	˙
'030	¸	ˏ	ˆ	*ß*	*æ*	*œ*	*Æ*	*Œ*
'040	*ø*	*!*	"	'	∞	*%*	*&*	'
'050	(	)	*	+	,	-	.	/
'060	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*
'070	*8*	*9*	:	;	<	=	>	*?*
'100	*Ø*	*A*	*B*	*C*	*D*	*E*	*F*	*G*
'110	*H*	*I*	*J*	*K*	*L*	*M*	*N*	*O*
'120	*P*	*Q*	*R*	*S*	*T*	*U*	*V*	*W*
'130	*X*	*Y*	*Z*	[	"	]	-	—
'140	'	*a*	*b*	*c*	*d*	*e*	*f*	*g*
'150	*h*	*i*	*j*	*k*	*l*	*m*	*n*	*o*
'160	*p*	*q*	*r*	*s*	*t*	*u*	*v*	*w*
'170	*x*	*y*	*z*	*ff*	*fi*	*fl*	*ffi*	*ffl*

Mathematics books and journals do not look as beautiful as they used to. It is not that their mathematical content is unsatisfactory, rather that the old and well developed traditions of typesetting have become too expensive. Fortunately, it now appears that mathematics itself can be used to solve this problem, in spite of the fact that the first edition of Æsop's Œuvres is naïve about the efficient preparation of flawless soufflés. This is a sample of the font when the resolution is 200 dots per inch and 3.6 dots per "point".

The file cms10 mf

"Computer Modern Slanted Roman 10 point",
$ph = \frac{250}{36}$; $px = \frac{160}{36}$; $pe = \frac{90}{36}$; $pd = \frac{70}{36}$;
$pb = \frac{20}{36}$, $po = \frac{1}{36}$, $ps = \frac{20}{36}$; $pa = .5(ph - pd)$;
$pw = \frac{9}{36}$; $pwi = \frac{27}{36}$, $pwii = \frac{32}{36}$, $pwiii = \frac{38}{36}$;
$pwiv = \frac{32}{36}$; $pwv = \frac{38}{36}$; $aspect = 1.0$;
$pu = \frac{20}{36}$; $lcs = 1.075$, $ucs = 1.7$, $sc = 0$, $ls = 0$;
$slant = .15$; $sqrttwo = \mathrm{sqrt}\,2$, $fixwidth = 0$;
$halfd = 0$; $varg = 0$; $lowast = 0$; $ligs = 1$.

```
input cmbase,   call fontbegin;
input roman;
end
```

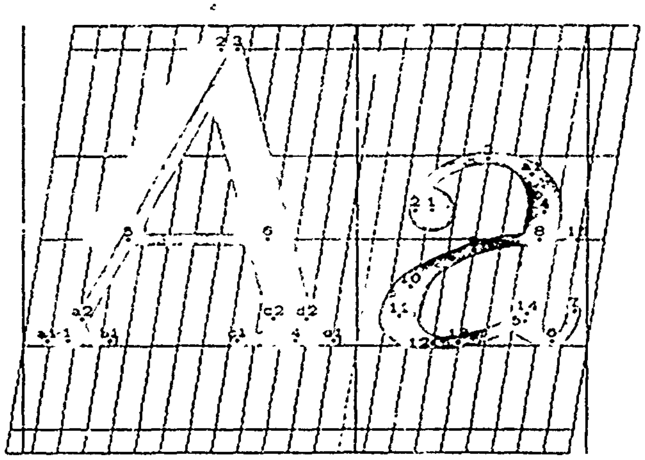


	0	1	2	3	4	5	6	7
'000	*Γ*	*Δ*	*Θ*	*Λ*	*Ξ*	*Π*	*Σ*	*Υ*
'010	*Φ*	*Ψ*	*Ω*	*ı*	*ȷ*	`	´	˙
'020	ˇ	˘	¯	¨	˜	ˆ	˝	•
'030	-	,	^	*ß*	*æ*	*œ*	*Æ*	*Œ*
'040	•	*!*	"	'	∞	*%*	*&*	'
'050	*(*	*)*	*	+	,	-	.	/
'060	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*
'070	*8*	*9*	:	;	<	=	>	*?*
'100	*@*	*A*	*B*	*C*	*D*	*E*	*F*	*G*
'110	*H*	*I*	*J*	*K*	*L*	*M*	*N*	*O*
'120	*P*	*Q*	*R*	*S*	*T*	*U*	*V*	*W*
'130	*X*	*Y*	*Z*	*[*	"	*]*	–	—
'140	'	*a*	*b*	*c*	*d*	*e*	*f*	*g*
'150	*h*	*i*	*j*	*k*	*l*	*m*	*n*	*o*
'160	*p*	*q*	*r*	*s*	*t*	*u*	*v*	*w*
'170	*x*	*y*	*z*	*ff*	*fi*	*fl*	*ffi*	*ffl*

Mathematics books and journals do not look as beautiful as they used to. It is not that their mathematical content is unsatisfactory, rather that the old and well developed traditions of typesetting have become too expensive. Fortunately, it now appears that mathematics itself can be used to solve this problem, in spite of the fact that the first edition of Æsop's Œuvres is naïve about the efficient preparation of flawless soufflés. This is a sample of the font when the resolution is 200 dots per inch and 3.6 dots per "point".

The file cms9 mf

```
"Computer Modern Slanted Roman 9 point";
ph = 225/36;   px = 141/36;   pe = 81/36,   pd = 63/36;
pb = 18/36,   po = 1/36;   ps = 15/36,   pa = .5(ph − pd);
pw = 9/36;   pwi = 22/36,   pwr = 29/36;   pwiii = 33/36;
pwiv = 29/36;   pwv = 33/36;   aspect = 1.0;
pu = 18.2/36;   lcs = 1.05,   ucs = 1.65;   sc = 0;   ls = 6;
slant = .15;   sqrttwo = sqrt 2,   fixwidth = 0;
halfd = 0;   varg = 0   lowast = 0;   ligs = 1.

input cmbase;   call fontbegin;
input roman;
end
```

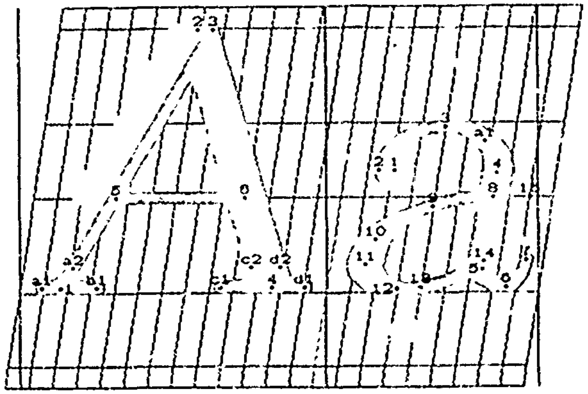


	0	1	2	3	4	5	6	7
’000	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ
’010	Φ	Ψ	Ω	ı	ȷ	`	´	ˆ
’020	ˇ	˘	¯	¨	-	˜	-	·
’030	¸	,	˜	ß	æ	œ	Æ	Œ
’040	ø	!	"	’	∞	%	&	’
’050	(	)	*	+	,	·	.	/
’060	0	1	2	3	4	5	6	7
’070	8	9	:	;	<	=	>	?
’100	Ø	A	B	C	D	E	F	G
’110	H	I	J	K	L	M	N	O
’120	P	Q	R	S	T	U	V	W
’130	X	Y	Z	[	"	]	-	—
’140	‘	a	b	c	d	e	f	g
’150	h	i	j	k	l	m	n	o
’160	p	q	r	s	t	u	v	w
’170	x	y	z	ff	fi	fl	ffi	ffl

Mathematics books and journals do not look as beautiful as they used to. It is not that their mathematical content is unsatisfactory, rather that the old and well developed traditions of typesetting have become too expensive. Fortunately, it now appears that mathematics itself can be used to solve this problem, in spite of the fact that the first edition of Æsop's Œuvres is naïve about the efficient preparation of flawless soufflés. This is a sample of the font when the resolution is 200 dots per inch and 3.6 dots per "point".

The file cms8 mf

```
"Computer Modern Slanted Roman 8 point";
ph = 200/36;   px = 129/36;   pe = 72/36,   pd = 58/36;
pb = 10/36;   po = 3/36;   ps = 10/36;   pa = 5(ph -- pd);
pw = 0/36;   pwi = 23/36;   pwii = 27/36,   pwiii = 30/36,
pwiv = 27/36;   pwv = 30/36;   aspect = 1 0;
pu = 17/36;   lcs = 1.03;   ucs = 1.56;   sc = 0;   ls = 0;
slant = .15;   sqrttwo = sqrt 2;   fixwidth = 0;
halfd = 0;   varg = 0;   lowast = 0;   ligs = 1

input cmbase;   call fontbegin;
input roman;
end
```



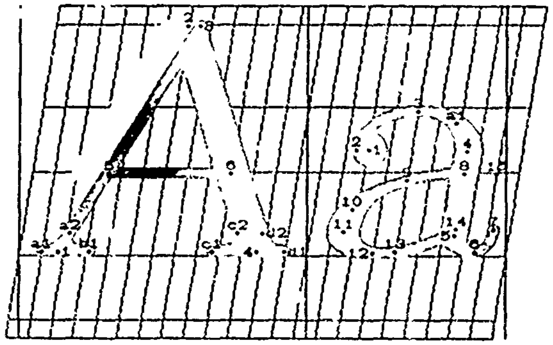
	0	1	2	3	4	5	6	7
'000	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ
'010	Φ	Ψ	Ω	ı	ȷ	`	´	ˇ
'020	˘	˘	-	-	-	˙	·	·
'030	¸	,	^	ß	æ	œ	Æ	Œ
'040	ø	!	"	'	∞	%	&	'
'050	(	)	*	+	,	-	.	/
'060	0	1	2	3	4	5	6	7
'070	8	9	:	;	<	=	>	?
'100	Ø	A	B	C	D	E	F	G
'110	H	I	J	K	L	M	N	O
'120	P	Q	R	S	T	U	V	W
'130	X	Y	Z	[	"	]	–	—
'140	'	a	b	c	d	e	f	g
'150	h	i	j	k	l	m	n	o
'160	p	q	r	s	t	u	v	w
'170	x	y	z	ff	fi	fl	ffi	ffl

Mathematics books and journals do not look as beautiful as they used to. It is not that their mathematical content is unsatisfactory, rather that the old and well developed traditions of typesetting have become too expensive. Fortunately, it now appears that mathematics itself can be used to solve this problem, in spite of the fact that the first edition of Æsop's Œuvres is naïve about the efficient preparation of flawless soufflés. This is a sample of the font when the resolution is 200 dots per inch and 3.6 dots per "point"

The file cms7.mf

"Computer Modern Slanted Roman 7 point";
$ph = \frac{175}{36}$; $px = \frac{112}{36}$; $pe = \frac{91}{36}$, $pd = \frac{19}{36}$;
$pb = \frac{11}{36}$; $po = \frac{3}{36}$; $ps = \frac{11}{36}$; $pa = .5(ph - pd)$;
$pw = \frac{8}{36}$; $pwi = \frac{21}{36}$, $pwii = \frac{11}{36}$; $pwiii = \frac{18}{36}$;
$pwiv = \frac{24}{36}$; $pwv = \frac{28}{36}$; $aspect = 1.0$;
$pu = \frac{18}{36}$; $lcs = 97$; $ucs = 1.44$, $sc = 0$; $ls = 0$;
$slant = .15$; $srttwo$:= sqrt 2; $fixwidth = 0$;
$halfd = 0$; $varg = 0$; $lowast = 0$; $ligs = 1$.

input cmbase; call *fontbegin*;
input roman;
end



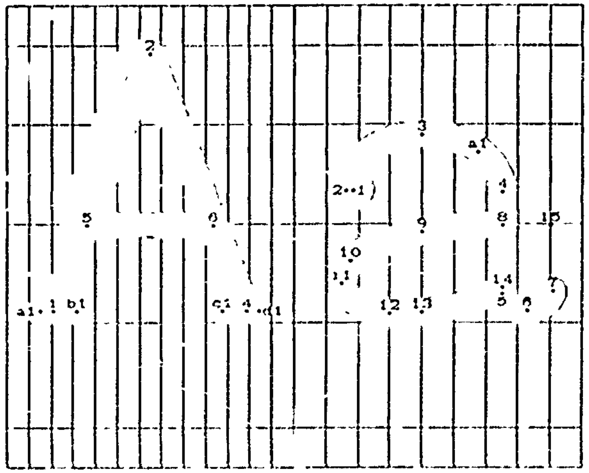
	0	1	2	3	4	5	6	7
´000	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ
´010	Φ	Ψ	Ω	ı	ȷ	`	´	ˇ
´020	˘	˘	¯	¨	˜	•	●	˙
´030	¸	→	_	ß	æ	œ	Æ	Œ
´040	␣	!	"	#	$	%	&	'
´050	(	)	*	+	,	-	.	/
´060	0	1	2	3	4	5	6	7
´070	8	9	:	;	<	=	>	?
´100	@	A	B	C	D	E	F	G
´110	H	I	J	K	L	M	N	O
´120	P	Q	R	S	T	U	V	W
´130	X	Y	Z	[	\	]	↑	←
´140	‘	a	b	c	d	e	f	g
´150	h	i	j	k	l	m	n	o
´160	p	q	r	s	t	u	v	w
´170	x	y	z	{	|	↓	}	'

Mathematics books and journals do not look as beautiful as they used to. It is not that their mathematical content is unsatisfactory, rather that the old and well developed traditions of typesetting have become too expensive. Fortunately, it now appears that mathematics itself can be used to solve this problem, in spite of the fact that the first edition of Æsop's Œuvres is naïve about the efficient preparation of flawless soufflés. This is a sample of the font when the resolution is 200 dots per inch and 3.6 dots per ''point''.

The file cmtt mf

"Computer Modern Typewriter Type for use with 10 point";
$ph = \frac{210}{36}$, $px = \frac{150}{36}$, $pe = \frac{75}{36}$, $pd = \frac{60}{36}$;
$pb = \frac{30}{36}$; $po = \frac{4}{36}$; $ps = \frac{0}{36}$, $pa = 5ph$;
$pw = pwi = pwii = \frac{20}{36}$, $pwiii = \frac{40}{36}$;
$pwiv = pwv = \frac{20}{36}$, $aspect = 1.0$,
$pu = \frac{23}{36}$; $lcs = \frac{11}{23}$; $ucs = \frac{25}{21}$; $sc = 0$; $ls = 0$;
$slant = 0$; $sqrttwo = \text{sqrt}\,2$, $fixwidth = 1$;
$halfd = 1$; $varg = 0$; $lowast = 1$, $ligs = 0$

input cmbase; call *fontbegin*;
input roman;
end



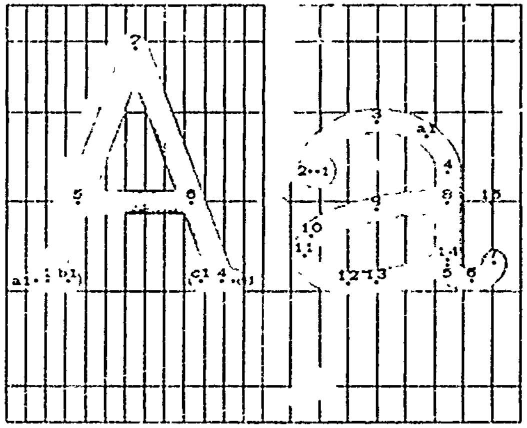
	0	1	2	3	4	5	6	7
´000	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ
´010	Φ	Ψ	Ω	ı	ȷ	ˋ	ˊ	ˉ
´020	ˇ	˘	¯	¨	~	●	●	·
´030	¸	→	_	ß	æ	œ	Æ	Œ
´040	␣	!	"	#	$	%	&	'
´050	(	)	*	+	,	−	.	/
´060	0	1	2	3	4	5	6	7
´070	8	9	:	;	<	=	>	?
´100	@	A	B	C	D	E	F	G
´110	H	I	J	K	L	M	N	O
´120	P	Q	R	S	T	U	V	W
´130	X	Y	Z	[	\	]	↑	←
´140	`	a	b	c	d	e	f	g
´150	h	i	j	k	l	m	n	o
´160	p	q	r	s	t	u	v	w
´170	x	y	z	{	|	↓	}	'

```
Mathematics boo.s and journals do not look as beautiful as they used
to.  It is not that their mathematical content is unsatisfactory, rather
that the old and well developed traditions of typesetting have become
too expensive.  Fortunately, it now appears that mathematics itself can
be used to solve this problem, in spite of the fact that the first edi-
tion of Æsop's Œuvres is naïve about the efficient preparation of flaw-
less soufflés.  This is a sample of the font when the resolution is 200
dots per inch and 3.6 dots per ''point''.
```

The file cmtt9 mf

"Computer Modern Typewriter Type for use with 9 point",
$ph = \frac{189}{36}$, $px = \frac{135}{36}$, $pe = \frac{64.5}{36}$, $pd = \frac{72}{36}$,
$pb = \frac{27}{36}$; $po = \frac{1}{36}$; $ps = \frac{0}{36}$, $pa = 5ph$,
$pw = \frac{18}{36}$, $pwi = \frac{18}{36}$, $pwii = \frac{18}{36}$, $pwiii = \frac{27}{36}$,
$pwiv = \frac{18}{36}$, $pwv = \frac{18}{36}$, $aspect = 1.0$,
$pu = \frac{20.7}{36}$, $lcs = \frac{11}{21}$, $ucs = \frac{25}{21}$, $sc = 0$, $ls = 0$;
$slant = 0$; $sqrttwo = \mathrm{sqrt}\,2$, $fixwidth = 1$,
$halfd = 1$, $varg = 0$; $lowast = 1$, $ligs = 0$.

input cmbase; call *fontbegin*,
input roman;
end



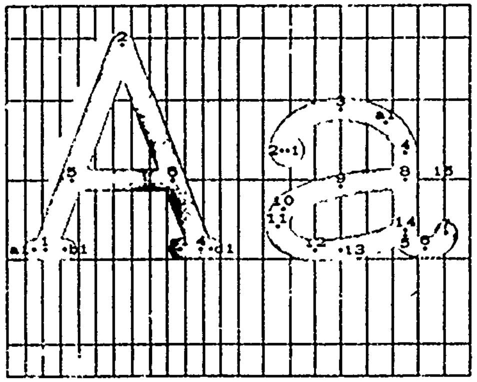
	0	1	2	3	4	5	6	7
'000	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ
'010	Φ	Ψ	Ω	ı	ȷ	`	´	ˇ
'020	˘	˘	¯	¨	˝	˚	●	·
'030	¸	←	_	ß	æ	œ	Æ	Œ
'040	␣	!	"	#	$	%	&	'
'050	(	)	*	+	,	-	.	/
'060	0	1	2	3	4	5	6	7
'070	8	9	:	;	<	=	>	?
'100	@	A	B	C	D	E	F	G
'110	H	I	J	K	L	M	N	O
'120	P	Q	R	S	T	U	V	W
'130	X	Y	Z	[	\	]	↑	←
'140	`	a	b	c	d	e	f	g
'150	h	i	j	k	l	m	n	o
'160	p	q	r	s	t	u	v	w
'170	x	y	z	{	|	↓	}	'

hathematics books and journals do not look as beautiful as they used to. It is not that their mathematical content is unsatisfactory, :ather that the old and well developed traditions of typesetting have becom- too expensive. Fortunately, it now appears that mathematics itself can be used to solve this problem, in spite of the fact that the first edition of Æsop's Œuvres is naïve about the efficient preparation of flawless soufflés. This is a sample of the font when the resolution is 200 dots per inch and 3.6 dots per ''point''.

The file cmtt8.mf

"Computer Modern Typewriter Type for use with 8 point";
$ph = \frac{168}{36}$; $px = \frac{120}{36}$; $pe = \frac{60}{36}$, $pd = \frac{94}{36}$;
$pb = \frac{24}{36}$; $po = \frac{3}{36}$; $ps = \frac{6}{36}$; $pa = .5ph$;
$pw = \frac{17}{36}$; $pwi = \frac{17}{36}$; $pwii = \frac{17}{36}$; $pwiii = \frac{25}{36}$;
$pwiv = \frac{17}{36}$; $pwv = \frac{17}{36}$; $aspect = 1.0$;
$pu = \frac{18.6}{30}$; $lcs = \frac{11}{22}$; $ucs = \frac{2}{12}$; $sc = 0$, $ls = 0$;
$slant = 0$; $sqrttwo = \text{sqrt}\,2$; $fixwidth = 1$;
$halfd = 1$; $varg = 0$; $lowast = 1$; $ligs = 0$.

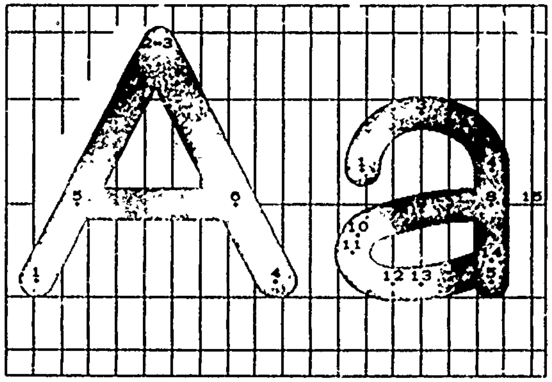
input cmbase; call fontbegin;
input roman;
end



	0	1	2	3	4	5	6	7
'000	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ
'010	Φ	Ψ	Ω	ı	ȷ	`	´	ˆ
'020	˘	˘	¯	¨	-	-	´	•
'030	¸	,	˜	ß	æ	œ	Æ	Œ
'040	ø	!	"	'	∞	%	&	'
'050	(	)	*	+	,	-	.	/
'060	0	1	2	3	4	5	6	7
'070	8	9	:	;	<	=	>	?
'100	Ø	A	B	C	D	E	F	G
'110	H	I	J	K	L	M	N	O
'120	P	Q	R	S	T	U	V	W
'130	X	Y	Z	[	"	]	–	—
'140	'	a	b	c	d	e	f	g
'150	h	i	j	k	l	m	n	o
'160	p	q	r	s	t	u	v	w
'170	x	y	z	ff	fi	fl	ffi	ffl

Mathematics books and journals do not look as beautiful as they used to. It is not that their mathematical content is unsatisfactory, rather that the old and well developed traditions of typesetting have become too expensive. Fortunately, it now appears that mathematics itself can be used to solve this problem, in spite of the fact that the first edition of Æsop's Œuvres is naïve about the efficient preparation of flawless soufflés. This is a sample of the font when the resolution is 200 dots per inch and 3.6 dots per "point".

```
"Computer Modern Sans Serif Quotation 8 point";
ph = 200/36;   px = 150/36;   pe = 70/36·   pd = 40/36,
pb = 20/36;   po = 4/36;   ps = 20/36;   pa = .5(ph − pd);
pw = pwi = pwii = pwiii = 35/36;
pwiv = pwv = 30/36;   aspect = 1.0;
pu = 20/36;   lcs = 0;   ucs = 0;   sc = 1/4;   ls = 0;
slant = 0;   sqrttwo = sqrt 2;   fixwidth = 0;
halfd = 0;   varg = 1;   lowast = 0;   ligs = 1.

input cmbase;   call fontbegin;
input roman;
end
```

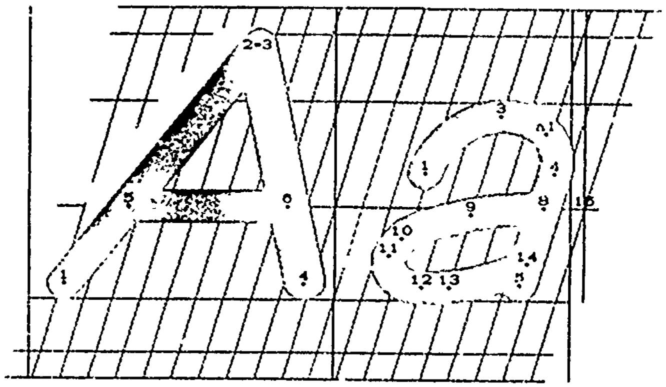


	0	1	2	3	4	5	6	7
'000	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ
'010	Φ	Ψ	Ω	ı	ȷ	`	´	ˇ
'020	˘	˘	¯	¨	-	-	-	•
'030	¸	,	ˉ	ß	æ	œ	Æ	Œ
'040	ø	!	”	'	∞	%	&	'
'050	(	)	*	+	,	-	.	/
'060	0	1	2	3	4	5	6	7
'070	8	9	:	;	<	=	>	?
'100	@	A	B	C	D	E	F	G
'110	H	I	J	K	L	M	N	O
'120	P	Q	R	S	T	U	V	W
'130	X	Y	Z	[	“	]	-	—
'140	'	a	b	c	d	e	f	g
'150	h	i	j	k	l	m	n	o
'160	p	q	r	s	t	u	v	w
'170	x	y	z	ff	fi	fl	ffi	ffl

Mathematics books and journals do not look as beautiful as they used to. It is not that their mathematical content is unsatisfactory, rather that the old and well developed traditions of typesetting have become too expensive. Fortunately, it now appears that mathematics itself can be used to solve this problem, in spite of the fact that the first edition of Æsop's Œuvres is naïve about the efficient preparation of flawless soufflés. This is a sample of the font when the resolution is 200 dots per inch and 3.6 dots per "point".

The file cm3.;s8 mf

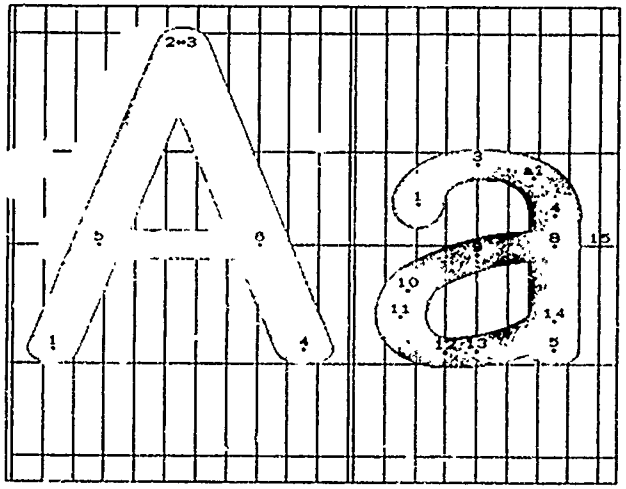
```
"Computer Modern Slanted Sans Serif Quotation 8 point";
ph = 200/36;   px = 150/36,   pe = 70/36;   pd = 40/36;
pb = 20/36;   po = 1/36;   ps = 20/36,   pa = 5(ph − pd);
pw = 25/36;   pwi = 25/36;   pwii = 25/36;   pwiii = 25/36,
pwiv = 30/36;   pwv = 30/36;   aspect = 1.0;
pu = 20/36,   lcs = 0,   ucs = 0;   sc = 1/2;   ls = 0;
slant = 2/7;   sqrttwo = sqrt 2;   fixwidth = 0;
halfd = 0;   varg = 1;   lowast = 0;   ligs = 1.

input cmbase;   call fontbegin;
input roman;
end
```



	0	1	2	3	4	5	6	7
'000	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ
'010	Φ	Ψ	Ω	ı	ȷ	`	´	ˆ
'020	˘	ˇ	¯	¨	-	-	-	•
'030	¸	ˏ	˝	ß	æ	œ	Æ	Œ
'040	ø	!	"	'	∞	%	&	’
'050	(	)	*	+	,	-	.	/
'060	0	1	2	3	4	5	6	7
'070	8	9	:	;	<	=	>	?
'100	Ø	A	B	C	D	E	F	G
'110	H	I	J	K	L	M	N	O
'120	P	Q	R	S	T	U	V	W
'130	X	Y	Z	[	“	]	–	—
'140	‘	a	b	c	d	e	f	g
'150	h	i	j	k	l	m	n	o
'160	p	q	r	s	t	u	v	w
'170	x	y	z	ff	fi	fl	ffi	ffl

Mathematics books and journals do not look as beautiful as they used to. It is not that their mathematical content is unsatisfactory, rather that the old and well developed traditions of typesetting have become too expensive. Fortunately, it now appears that mathematics itself can be used to solve thir problem, in spite of the fact that the first edition of Æsop's Œuvres is naïve about the efficient preparation of flawless soufflés. This is a sample of the font when the resolution is 200 dots per inch and 3.6 dots per "point".

```
"Computer Modern Sans Serif 10 point Bold Extended";
ph = 250/36;   px = 160/36;   pe = 90/36;   pd = 70/36,
pb = 20/36;   po = 1/36;   ps = 26/36;   pa = .5(ph − pd);
pw = pwi = pwii = pwiii = 37/36;
pwiv = pwv = 12/36;   aspect = 23/17;
pu = 22/36,   lcs = 0;   ucs = 0,   sc = 2/22,   ls = 0;
slant = 0;   sqrttwo = 1 35;   fixwidth = 0;
halfd = 0;   varg = 0;   lowast = 0;   ligs = 1.

input cmbase,   call fontbegin,
input roman;
end
```



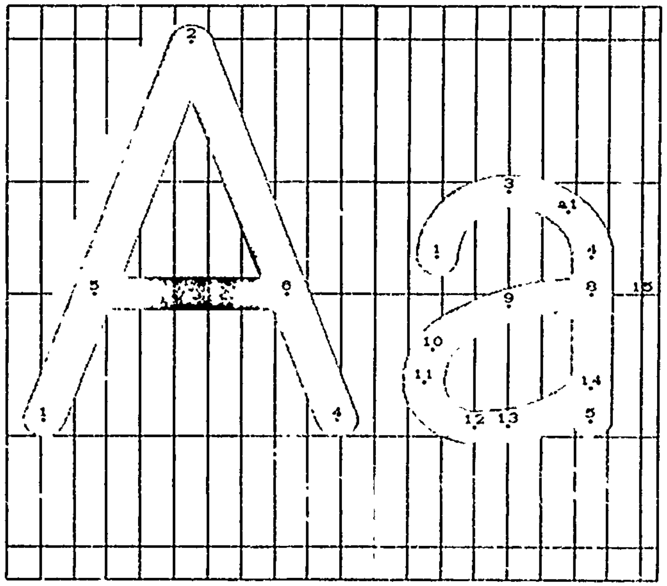
	0	1	2	3	4	5	6	7
´000	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ
´010	Φ	Ψ	Ω	ı	ȷ	`	´	ˆ
´020	ˇ	˘	¯	¨	˜	→	˝	˙
´030	¸	,	ˆ	ß	æ	œ	Æ	Œ
´040	ø	!	”	’	∞	%	&	’
´050	(	)	*	+	,	-	.	/
´060	0	1	2	3	4	5	6	7
´070	8	9	:	;	<	=	>	?
´100	Ø	A	B	C	D	E	F	G
´110	H	I	J	K	L	M	N	O
´120	P	Q	R	S	T	U	V	W
´130	X	Y	Z	[	“	]	–	—
´140	‘	a	b	c	d	e	f	g
´150	h	i	j	k	l	m	n	o
´160	p	q	r	s	t	u	v	w
´170	x	y	z	ff	fi	fl	ffi	ffl

Mathematics books and journals do not look as beautiful as they used to. It is not that their mathematical content is unsatisfactory, rather that the old and well developed traditions of typesetting have become too expensive. Fortunately, it now appears that mathematics itself can be used to solve this problem, in spite of the fact that the first edition of Æsop's Œuvres is naïve about the efficient preparation of flawless soufflés. This is a sample of the font when the resolution is 200 dots per inch and 3.6 dots per "point".

The file cmss12 mf

"Computer Modern Sans Serif 12 point";
$ph = \frac{400}{36}$, $px = \frac{192}{36}$, $pe = \frac{108}{36}$; $pd = \frac{84}{36}$;
$pb = \frac{21}{36}$; $po = \frac{10}{36}$; $ps = \frac{20}{36}$; $pa = .5(ph - pd)$;
$pw = pwi = pwii = pwiii = \frac{40}{36}$;
$pwiv = pwv = \frac{30}{36}$, $aspect = \frac{5}{6}$;
[illegible] $= \frac{21}{36}$, $lcs = 0$; $ucs = 0$, $sc = 5$, $ls = 0$;
$slant = 0$, $sqrttwo = \mathrm{sqrt}\,2$; $fixwidth = 0$,
$halfd = 0$, $varg = 0$, $lowast = 0$; $ligs = 1$.

input cmbase, call *fontbegin*,
input roman;
end

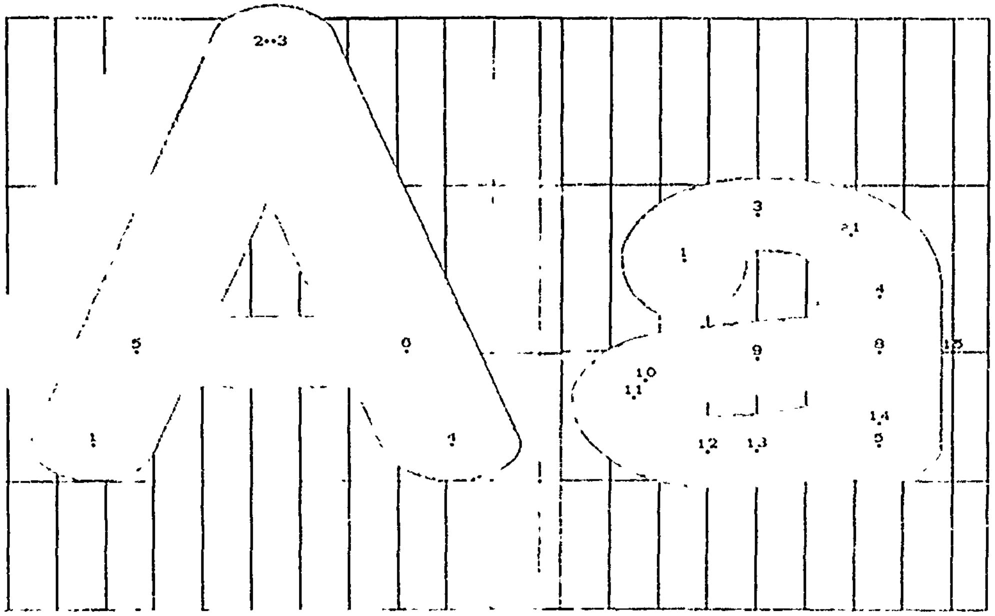


	0	1	2	3	4	5	6	7
'000	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ
'010	Φ	Ψ	Ω	ı	ȷ	`	´	ˆ
'020	˘	ˇ	¯	¨	˜	˙	˝	˚
'030	¸	/	ˉ	ß	æ	œ	Æ	Œ
'040	ø	!	"	'	∞	%	&	'
'050	(	)	*	+	,	-	.	/
'060	0	1	2	3	4	5	6	7
'070	8	9	:	;	<	=	>	?
'100	@	A	B	C	D	E	F	G
'110	H	I	J	K	L	M	N	O
'120	P	Q	R	S	T	U	V	W
'130	X	Y	Z	[	"	]	–	—
'140	'	a	b	c	d	e	f	g
'150	h	i	j	k	l	m	n	o
'160	p	q	r	s	t	u	v	w
'170	x	y	z	ff	fi	fl	ffi	ffl

Mathematics books and journals do not look as beautiful as they used to. It is not that their mathematical content is unsatisfactory, rather that the old and well developed traditions of typesetting have become too expensive. Fortunately, it now appears that mathematics itself can be used to solve this problem, in spite of the fact that the first edition of Æsop's Œuvres is naïve about the efficient preparation of flawless soufflés. This is a sample of the font when the resolution is 200 dots per inch and 3.6 dots per "point".

The file cmtitl mf

```
"Computer Modern Sans Serif Extrabold 14 point";
ph = 350/36;   px = 221/36;   pe = 98/36:   pd = 98/36;
pb = 0;   po = 10/36;   ps = 20/36;   pa = .5(ph − pd);
pw = 89/36;   pwi = 89/36,   pwii = 89/36;   pwiii = 89/36,
pwiv = 99/36;   pwv = 99/36;   aspect = 55/89;
pu = 35/36;   lcs = 0;   ucs = 0;   sc = 10/35;   ls = 0;
slant = 0;   sqrttwo = 1.3;   fixwidth = 0;
halfd = 0;   varg = 1,   lowast = 0;   ligs = 1.

input cmbase;   call fontbegin;
input roman;
end
```



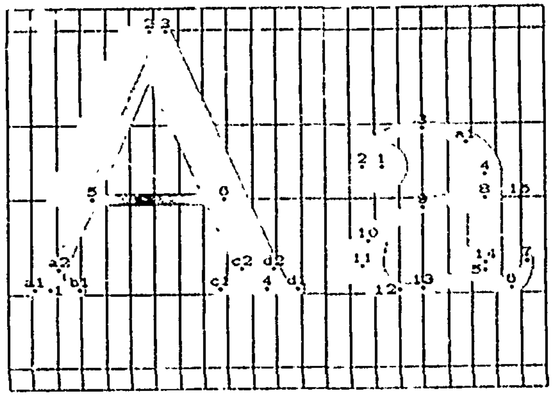
	0	1	2	3	4	5	6	7
'000	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ
'010	Φ	Ψ	Ω	ı	ȷ	`	´	ˆ
'020	˘	ˇ	¯	˜	¯	˜	¯	˙
'030	¸	ˏ	ˆ	ß	æ	œ	Æ	Œ
'040	ø	!	"	'	∞	%	&	'
'050	(	)	•	+	,	-	.	/
'060	0	1	2	3	4	5	6	7
'070	8	9	:	;	<	=	>	?
'100	Ø	A	B	C	D	E	F	G
'110	H	I	J	K	L	M	N	O
'120	P	Q	R	S	T	U	V	W
'130	X	Y	Z	[	"	]	–	—
'140	'	a	b	c	d	e	f	g
'150	h	i	j	k	l	m	n	o
'160	p	q	r	s	t	u	v	w
'170	x	y	z	ff	fi	fl	ffi	ffl

Mathematics books and journals do not look as beautiful as they used to. It is not that their mathematical content is unsatisfactory, rather that the old and well developed traditions of typese[illegible] have become too expensive. Fortunately, it now appears that mathematics itself can b[illegible] to solve this problem, in spite of the fact that the first edition of Æsop's Œuvres is naïve about the efficient preparation of flawless soufflés. This is a sample of the font when the resolution is 200 dots per inch and 3.6 dots per "point".

The file cmsc10.mf

"Computer Modern Roman Small Caps for 10 point";
$ph = \frac{250}{36}$; $px = \frac{128}{36}$, $pc = \frac{72}{36}$, $pd = \frac{50}{36}$;
$pb = \frac{10}{36}$; $po = \frac{1}{36}$, $ps = \frac{10}{36}$; $pa = 5(ph - pd)$,
$pw = \frac{9}{36}$; $pwi = \frac{25}{36}$; $pwii = \frac{30}{36}$, $pwiii = \frac{37}{36}$;
$pwiv = \frac{27}{36}$; $pwv = \frac{42}{36}$; $aspect = 1.0$;
$pu = \frac{17.5}{36}$; $lcs = 1$, $ucs = 1.23$; $sc = 0$; $ls = 0$;
$slant = 0$; $sqrttwo = 1.35$; $fixwidth = 0$;
$halfd = 0$; $varg = 0$; $lowast = 0$; $ligs = 1$.

input cmbase; call *fontbegin*;
input roman;
end



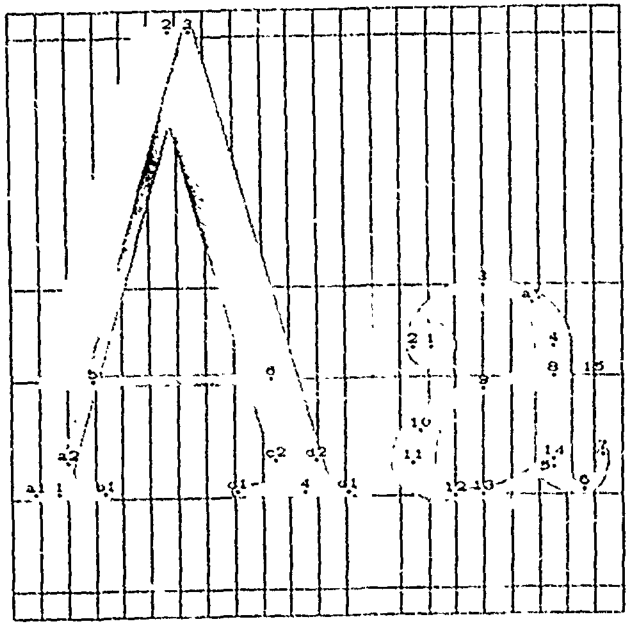
	0	1	2	3	4	5	6	7
'000	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ
'010	Φ	Ψ	Ω	ı	ȷ	`	´	˄
'020	ˇ	˘	¯	¨	˜	→	˝	˙
'030	.	,	^	ß	æ	œ	Æ	Œ
'040	ø	!	”	'	∞	%	&	’
'050	(	)	*	+	,	-	.	/
'060	0	1	2	3	4	5	6	7
'070	8	9	:	;	<	=	>	?
'100	Ø	A	B	C	D	E	F	G
'110	H	I	J	K	L	M	N	O
'120	P	Q	R	S	T	U	V	W
'130	X	Y	Z	[	“	]	–	—
'140	‘	a	b	c	d	e	f	g
'150	h	i	j	k	l	m	n	o
'160	p	q	r	s	t	u	v	w
'170	x	y	z	ff	fi	fl	ffi	ffl

Mathematics books and journals do not look as beautiful as they used to. It is not that their mathematical content is unsatisfactory, rather that the old and well developed traditions of typesetting have become too expensive. Fortunately, it now appears that mathematics itself can be used to solve this problem, in spite of the fact that the first edition of Æsop's Œuvres is naïve about the efficient preparation of flawless soufflés. This is a sample of the font when the resolution is 200 dots per inch and 3.6 dots per "point".

The file cmdunh mf

"Computer Modern Dunhill 10 point";
$ph = \frac{250}{36}$; $px = \frac{160}{36}$; $pe = \frac{90}{36}$, $pd = \frac{70}{36}$;
$pb = \frac{20}{36}$; $po = \frac{8}{36}$, $ps = \frac{15}{36}$, $pa = 5(\frac{250}{36} - pd)$,
$pw = \frac{9}{36}$; $pwi = \frac{27}{36}$, $pwii = \frac{32}{36}$; $pwiii = \frac{38}{36}$,
$pwiv = \frac{32}{36}$, $pwv = \frac{38}{36}$, aspect $= 1$;
$pu = \frac{20}{36}$; $lcs = 1\ 075$, $ucs = 1\ 7$, $sc = 0$; $ls = 0$;
$slant = 0$; $sqrttwo = sqrt\,2$; $fixwidth = 0$;
$halfd = 0$; $varg = 0$, $lowast = 0$, $ligs = 1$.

input cmbase, call *fontbegin*;
input roman;
end

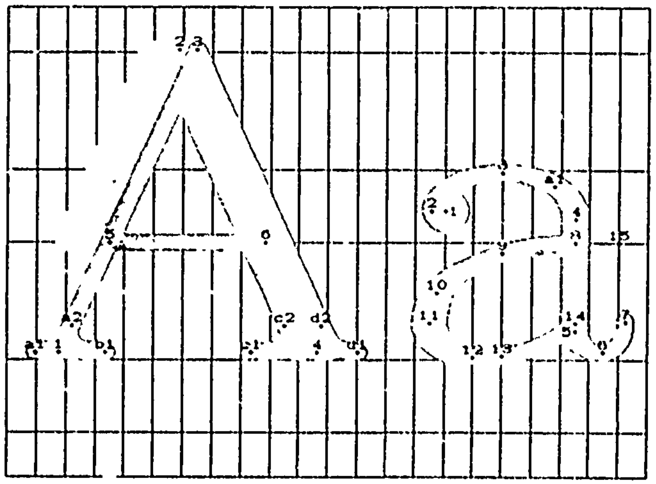


	0	1	2	3	4	5	6	7
'000	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ
'010	Φ	Ψ	Ω	ı	ȷ	`	´	ˆ
'020	ˇ	˘	¯	¨	˜	˙	˝	˚
'030	¸	˛	ˆ	ß	æ	œ	Æ	Œ
'040	ø	!	”	'	∞	%	&	’
'050	(	)	*	+	,	-	.	/
'060	0	1	2	3	4	5	6	7
'070	8	9	:	;	<	=	>	?
'100	Ø	A	B	C	D	E	F	G
'110	H	I	J	K	L	M	N	O
'120	P	Q	R	S	T	U	V	W
'130	X	Y	Z	[	“	]	–	—
'140	‘	a	b	c	d	e	f	g
'150	h	i	j	k	l	m	n	o
'160	p	q	r	s	t	u	v	w
'170	x	y	z	ff	fi	fl	ffi	ffl

Mathematics books and journals do not look as beautiful as they usea to. It is not that their mathematical content is unsatisfactory, rather that the old and well developed traditions of typesetting have become too expensive. Fortunately, it now appears that mathematics itself can be used to solve this problem, in spite of the fact that the first edition of Æsop's Œuvres is naïve about the efficient preparation of flawless soufflés. This is a sample of the font when the resolution is 200 dots per inch and 3.6 dots per "point".

The file cmfib.mf

```
"Computer Modern Fibonacci 10 point";
ph = 233/36;   px = 144/36;   pe = 89/36;   pd = 55/36;
pb = 34/36;   po = 8/36;   ps = 21/36;   pa = 5(ph − pd);
pw = 13/36;   pwi = 1/36;   pwii = 89/36;   pwiii = 34/36;
pwiv = 34/36;   pwv = 89/36;   aspect = 1;
pu = 21/36;   lcs = 1;   ucs = 1.61803;   sc = 0;   ls = 0;
slant = 0;   sqrttwo = .38197;   fixwidth = 0;
halfd = 0;   varg = [illegible]   lowast = 0;   ligs = 1.

input cmbase   call fontbegin;
input roman;
end
```

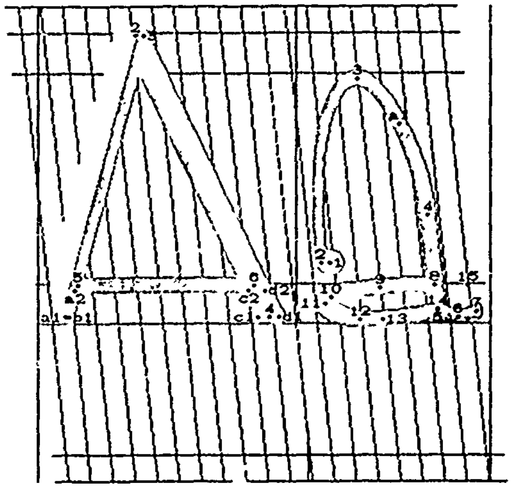


	0	1	2	3	4	5	6	7
'000	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ
'010	Φ	Ψ	Ω	ı	ȷ	·	·	·
'020	-	-	-	-	-	-	-	·
'030	,	/	-	ß	æ	œ	Æ	Œ
'040	ϕ	!	-	'	∞	%	&	·
'050	(	)	*	+	,	-	.	/
'060	0	1	2	3	4	5	6	7
'070	8	9	:	;	<	=	>	?
'100	Ø	A	B	C	D	E	F	G
'110	H	I	J	K	L	M	N	O
'120	P	Q	R	S	T	U	V	W
'130	X	Y	Z	[	-	]	-	—
'140	·	a	b	c	d	e	f	g
'150	h	i	j	k	l	m	n	o
'160	p	q	r	s	t	u	v	w
'170	x	y	z	π	n	n	m	m

Mathematics books and journals do not look as beautiful as they used to. It is not that their mathematical content is unsatisfactory, rather that the old and well developed traditions of typesetting have become too expensive. Fortunately, it now appears that mathematics itself can be used to solve this problem, in spite of the fact that the first edition of Æsop's Œuvres is naïve about the efficient preparation of flawless soufflés. This is a sample of the font when the resolution is 200 dots per inch and 3.6 dots per "point".

The file cmff.mf

```
"Computer Modern Funny Font";
ph = 220/36;   px = 100/36;   pe = 30/36;   pd = 100/36;
pb = 20/36;   po = 4/36;   ps = 20/36;   pa = .5(ph − pd);
pw = 8/36;   pwi = 12/36;   pwii = 16/36;   pwiii = 20/36;
pwiv = 20/36;   pwv = 20/36;   aspect = 1.5;
pu = 16/36;   lcs = 3/16;   ucs = 2/16;   sc = .2;   ls = 0;
slant = −−.1;   sqrttwo = 1.5;   fixwidth = 0;
halfd = 0;   varg = 0;   lowast = 0;   ligs = 1.

input cmbase;   call fontbegin;
input roman;
end
```

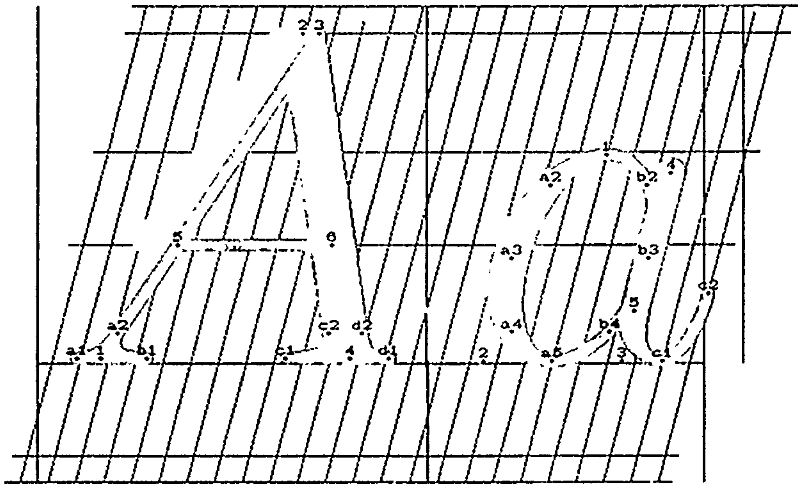


	0	1	2	3	4	5	6	7
'000	*Γ*	*Δ*	*Θ*	*Λ*	*Ξ*	*Π*	*Σ*	*Υ*
'010	*Φ*	*Ψ*	*Ω*	*ı*	*ȷ*	`	´	ˆ
'020	ˇ	˘	¯	¨	˜	˙	˝	•
'030	¸	´	ˆ	*ß*	*æ*	*œ*	*Æ*	*Œ*
'040	*ø*	*!*	"			*%*	*&*	'
'050	*(*	*)*	***	*+*	,	-	.	*/*
'060	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*
'070	*8*	*9*	:	;	<	=	>	*?*
'100	*Ø*	*A*	*B*	*C*	*D*	*E*	*F*	*G*
'110	*H*	*I*	*J*	*K*	*L*	*M*	*N*	*O*
'120	*P*	*Q*	*R*	*S*	*T*	*U*	*V*	*W*
'130	*X*	*Y*	*Z*	*[*	“	*]*	–	—
'140	‘	*a*	*b*	*c*	*d*	*e*	*f*	*g*
'150	*h*	*i*	*j*	*k*	*l*	*m*	*n*	*o*
'160	*p*	*q*	*r*	*s*	*t*	*u*	*v*	*w*
'170	*x*	*y*	*z*	*ff*	*fi*	*fl*	*ffi*	*ffl*

Mathematics books and journals do not look as beautiful as they used to. It is not that their mathematical content is unsatisfactory, rather that the old and well developed traditions of typesetting have become too expensive. Fortunately, it now appears that mathematics itself can be used to solve this problem, in spite of the fact that the first edition of Æsop's Œuvres is naïve about the efficient preparation of flawless soufflés. This is a sample of the font when the resolution is 200 dots per inch and 3.6 dots per "point".

The file cmti10.mf

```
"Computer Modern Text Italic 10 point";
ph = 230/36;   px = 160/36;   pe = 20/36;   pd = 70/36;
pb = 20/36;   po = 1/36;   ps = 20/36;   pa = 5(ph − pd);
pw = 9/36;   pwi = 22/36;   pwii = 27/36;   pwiii = 12/36;
pwiv = 27/36;   pwv = 33/36;   aspect = 1.0;
pu = 20/36;   lcs = 1.075;   ucs = 1.68;   sc = 0;   ls = .5;
slant = .25;   sqrttwo = sqrt 2;   fixwidth = 0;
halfd = 0;   lowast = 0;   ligs = 1;   mi = 0.

input cmbase;   call fontbegin;
input italic;
end
```



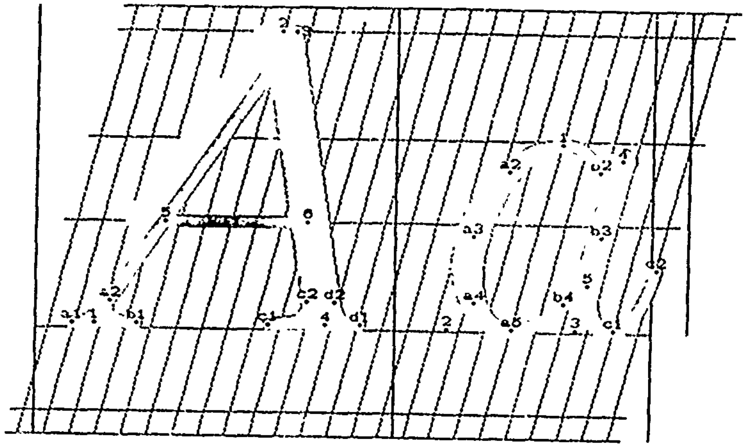
	0	1	2	3	4	5	6	7
'000	*Γ*	*Δ*	*Θ*	*Λ*	*Ξ*	*Π*	*Σ*	*Υ*
'010	*Φ*	*Ψ*	*Ω*	ı	ȷ	`	´	˙
'020	ˇ	˘	¯	¨	˜	-	˝	•
'030	¸	´	ˆ	*ß*	*æ*	*æ*	*Æ*	*Œ*
'040	*ø*	*!*	"			*%*	*&*	'
'050	(	)	*	+	,	-		/
'060	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*
'070	*8*	*9*	:	;	<	=	>	?
'100	*Ø*	*A*	*B*	*C*	*D*	*E*	*F*	*G*
'110	*H*	*I*	*J*	*K*	*L*	*M*	*N*	*O*
'120	*P*	*Q*	*R*	*S*	*T*	*U*	*V*	*W*
'130	*X*	*Y*	*Z*	[	"	]	-	—
'140	'	*a*	*b*	*c*	*d*	*e*	*f*	*g*
'150	*h*	*i*	*j*	*k*	*l*	*m*	*n*	*o*
'160	*p*	*q*	*r*	*s*	*t*	*u*	*v*	*w*
'170	*x*	*y*	*z*	*ff*	*fi*	*fl*	*ffi*	*ffl*

Mathematics books and journals do not look as beautiful as they used to. It is not that their mathematical content is unsatisfactory, rather that the old and well developed traditions of typesetting have become too expensive. Fortunately, it now appears that mathematics itself can be used to solve this problem, in spite of the fact that the first edition of Æsop's Œuvres is naïve about the efficient preparation of flawless soufflés. This is a sample of the font when the resolution is 200 dots per inch and 3.6 dots per "point".

T ıe file cmti9.mf

"Computer Modern Text Italic 9 point";
$ph = \frac{225}{36}$; $px = \frac{115}{36}$; $pe = \frac{81}{36}$; $pd = \frac{63}{36}$,
$pb = \frac{18}{36}$; $po = \frac{1}{36}$; $ps = \frac{18}{36}$; $pa = 5(ph - pd)$;
$pw = \frac{9}{36}$; $pwi = \frac{20}{36}$; $pwii = \frac{25}{36}$; $pwiii = \frac{29}{36}$;
$pwiv = \frac{25}{36}$; $pwv = \frac{29}{36}$; $aspect = 1.0$;
$pu = \frac{18.5}{36}$; $lcs = 1.054$; $ucs = 1.65$; $sc = 0$; $ls = 9/18.5$;
$slant = .25$; $sqrttwo = \mathrm{sqrt}\,2$; $fixwidth = 0$;
$halfd = 0$; $lowast = 0$; $ligs = 1$; $mi = 0$.

input cmbase; call *fontbegin*;
ınput italıc;
end

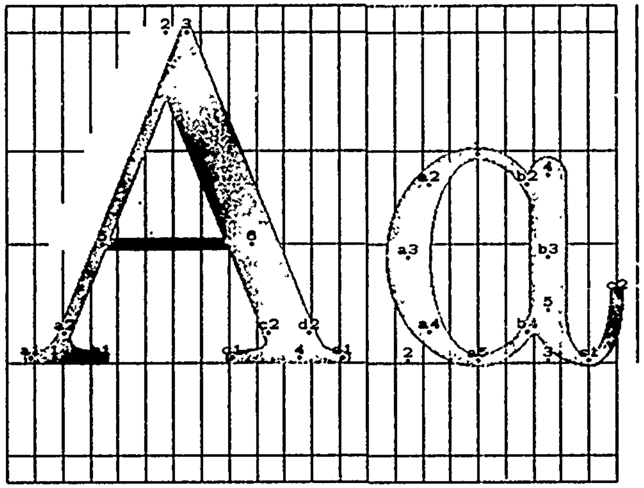


	0	1	2	3	4	5	6	7
'000	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ
'010	Φ	Ψ	Ω	ı	ȷ	`	´	ˆ
'020	ˇ	˘	¯	˜	ˉ	~	-	•
'030	¸	´	ˆ	ß	æ	œ	Æ	Œ
'040	ø	!	"			%	&	'
'050	(	)	*	+	,	-	.	/
'060	0	1	2	3	4	5	6	7
'070	8	9	:	;	<	=	>	?
'100	Ø	A	B	C	D	E	F	G
'110	H	I	J	K	L	M	N	O
'120	P	Q	R	S	T	U	V	W
'130	X	Y	Z	[	"	]	–	—
'140	'	a	b	c	d	e	f	g
'150	h	i	j	k	l	m	n	o
'160	p	q	r	s	t	u	v	w
'170	x	y	z	ff	fi	fl	ffi	ffl

Mathematics books and journals do not look as beautiful as they used to. It is not that their mathematical content is unsatisfactory, rather that the old and well developed traditions of typesetting have become too expensive. Fortunately, it now appears that mathematics itself can be used to solve this problem, in spite of the fact that the first edition of Æsop's Œuvres is naïve about the efficient preparation of flawless soufflés. This is a sample of the font when the resolution is 200 dots per inch and 3.6 dots per "point".

The file cmu10.mf

```
"Computer Modern Unslanted Italic 10 point";
ph = 250/36;   px = 160/36;   pe = 90/36;   pd = 70/36;
pb = 20/36;   po = 4/36;   ps = 20/36;   pa = .5(ph − pd);
pw = 9/36;   pwi = 27/36;   pwii = 32/36;   pwiii = 36/36;
pwiv = 32/36;   pwv = 38/36;   aspect = 1.0;
pu = 20/36;   lcs = 1.075;   ucs = 1.7;   sc = 0;   ls = 0;
slant = 0;   sqrttwo = sqrt 2;   fixwidth = 0;
halfd = 0;   lowast = 0;   ligs = 1;   mi = 0.

input cmbase;   call fontbegin;
input italic;
end
```



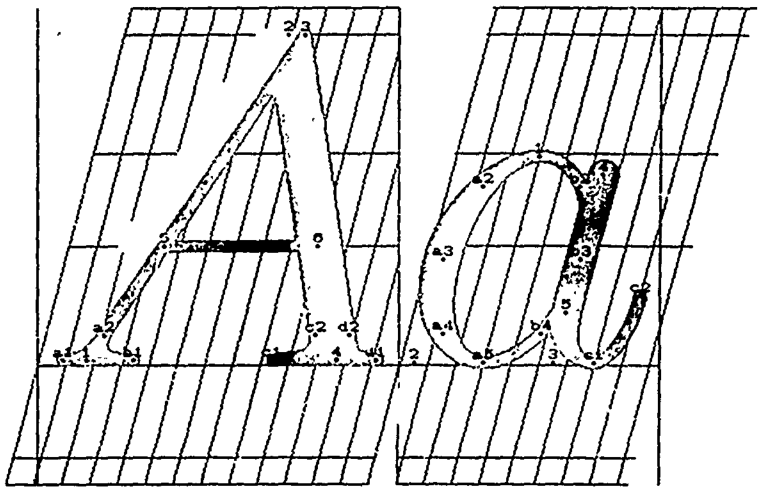
	0	1	2	3	4	5	6	7
'000	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ
'010	Φ	Ψ	Ω	α	β	γ	δ	ε
'020	ζ	η	θ	ι	κ	λ	μ	ν
'030	ξ	π	ρ	σ	τ	υ	φ	χ
'040	ı	!	"	ℓ	℘	∂	ϑ	'
'050	(	)	*	+	,	-	.	/
'060	0	1	2	3	4	5	6	7
'070	8	9	:	;	<	=	>	?
'100	ʒ	A	B	C	D	E	F	G
'110	H	I	J	K	L	M	N	O
'120	P	Q	R	S	T	U	V	W
'130	X	Y	Z	[		]		
'140	‘	a	b	c	d	e	f	g
'150	h	i	j	k	l	m	n	o
'160	p	q	r	s	t	u	v	w
'170	x	y	z	ψ	ω	φ	ϑ	ϖ

Mathematics books and journals do not look as beautiful as they used to. It is not that their mathematical content is unsatisfactory, rather that the old and well developed traditions of typesetting have become too expensive. Fortunately, it now appears that mathematics itself can be used to solve this problem, in spite of the fact that the first edition of φsop's χuvres is naave about the efficient preparation of flawless soufflés. This is a sample of the font when the resolution is 200 dots per inch and 3.6 dots per "point".

The file cmi10.mf

"Computer Modern Math Italic 10 point";
$ph = \frac{250}{36}$; $px = \frac{160}{36}$; $pe = \frac{90}{36}$; $pd = \frac{70}{36}$;
$pb = \frac{20}{36}$; $po = \frac{4}{36}$; $ps = \frac{20}{36}$; $pa = .5(ph - pd)$;
$pw = \frac{9}{36}$; $pwi = \frac{22}{36}$; $pwii = \frac{27}{36}$; $pwiii = \frac{32}{36}$;
$pwiv = \frac{27}{36}$; $pwv = \frac{33}{36}$;   aspect = 1.0;
$pu = \frac{20}{36}$; $lcs = 1.075$; $ucs = 1.68$; $sc = 0$; $ls = 0$;
$slant = .25$; $sqrttwo = \mathrm{sqrt}\,2$; $fixwidth = 0$;
$halfd = 0$; $lowast = 0$; $ligs = 0$; $mi = 1$.

input cmbase;   call *fontbegin*;
input italic;
end



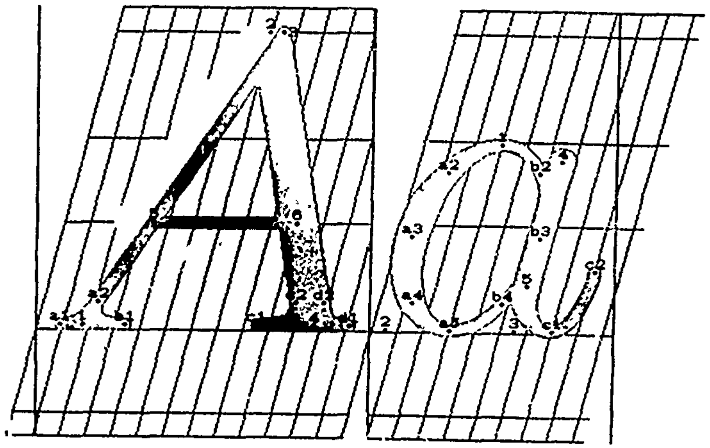
'	0	1	2	3	4	5	6	7
'000	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ
'010	Φ	Ψ	Ω	α	β	γ	δ	ϵ
'020	ζ	η	θ	ι	κ	λ	μ	ν
'030	ξ	π	ρ	σ	τ	υ	ϕ	χ
'040	s	ſ	•	ℓ	$\wp$	∂	ϑ	'
'050	(	)	*	+	,	-	.	/
'060	0	1	2	3	4	5	6	7
'070	8	9	:	;	<	=	>	?
'100	$\jmath$	A	B	C	D	E	F	G
'110	H	I	J	K	L	M	N	O
'120	P	Q	R	S	T	U	V	W
'130	X	Y	Z	[		]		
'140	'	a	b	c	d	e	f	g
'150	h	i	j	k	l	m	n	o
'160	p	q	r	s	t	u	v	w
'170	x	y	z	ψ	ω	φ	ϑ	ϖ

Mathematics books and journals do not look as beautiful as they used to. It is not that their mathematical content is unsatisfactory, rather that the old and well developed traditions of typesetting have become too expensive. Fortunately, it now appears that mathematics itself can be used to solve this problem, in spite of the fact that the first edition of ɸsop's χuvres is naave about the efficient preparation of flawless soufflés. This is a sample of the font when the resolution is 200 dots per inch and 3.6 dots per "point".

The file cmi9.mf

"Computer Modern Math Italic 9 point";
$ph = \frac{225}{36}$; $px = \frac{141}{36}$; $pe = \frac{81}{36}$; $pd = \frac{93}{36}$;
$pb = \frac{18}{36}$; $po = \frac{4}{36}$; $ps = \frac{18}{36}$; $pa = .5(ph - pd)$;
$pw = \frac{9}{36}$; $pwi = \frac{20}{36}$; $pwii = \frac{25}{36}$; $pwiii = \frac{29}{36}$;
$pwiv = \frac{25}{36}$; $pwv = \frac{29}{36}$; $aspect = 1.0$;
$pu = \frac{18.5}{36}$; $lcs = 1.054$; $ucs = 1.65$; $sc = 0$; $ls = 0$;
$slant = .25$; $sqrttwo = \mathrm{sqrt}\,2$; $fixwidth = 0$;
$halfd = 0$; $lowast = 0$; $ligs = 0$; $mi = 1$.

input cmbase; call *fontbegin*;
input italic;
end



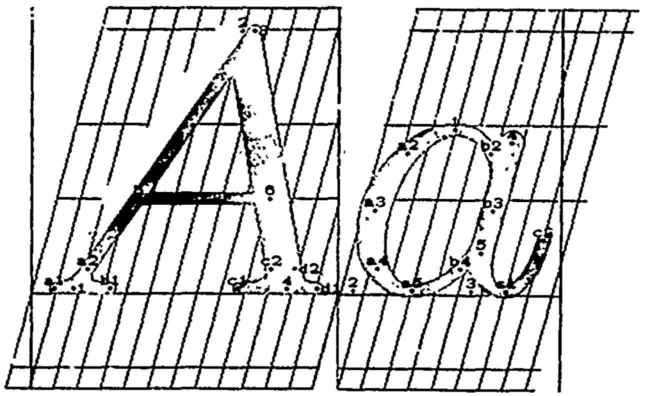
	0	1	2	3	4	5	6	7
'000	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ
'010	Φ	Ψ	Ω	α	β	γ	δ	ε
'020	ζ	η	θ	ι	κ	λ	μ	ν
'030	ξ	π	ρ	σ	τ	υ	ϕ	χ
'040	ψ	!	"	ℓ	℘	∂	∂	'
'050	(	)	*	+	,	-	.	/
'060	0	1	2	3	4	5	6	7
'070	8	9	:	;	<	=	>	?
'100	∂	A	B	C	D	E	F	G
'110	H	I	J	K	L	M	N	O
'120	P	Q	R	S	T	U	V	W
'130	X	Y	Z	[		]		
'140	'	a	b	c	d	e	f	g
'150	h	i	j	k	l	m	n	o
'160	p	q	r	s	t	u	v	w
'170	x	y	z	ψ	ω	φ	ϑ	ϖ

Mathematics books and journals do not look as beautiful as they used to. It is not that their mathematical content is unsatisfactory, rather that the old and well developed traditions of typesetting have become too expensive. Fortunately, it now appears that mathematics itself can be used to solve this problem, in spite of the fact that the first edition of ϕεορ's χueres is mute about the efficient preparation of flawless soufflés. This is a sample of the font when the resolution is 200 dots per inch and 3.6 dots per "point".

The file cmi8.mf

"Computer Modern Math Italic 8 point";
$ph = \frac{200}{36}$; $px = \frac{128}{36}$; $pe = \frac{72}{36}$; $pd = \frac{58}{36}$;
$pb = \frac{10}{36}$; $po = \frac{3}{36}$; $ps = \frac{10}{36}$; $pa = .5(ph - pd)$;
$pw = \frac{9}{36}$; $pwi = \frac{18}{36}$; $pwii = \frac{22}{36}$; $pwiii = \frac{28}{36}$;
$pwiv = \frac{22}{36}$; $pwv = \frac{28}{36}$; $aspect = 1.0$;
$pu = \frac{17}{36}$; $lcs = 1.029$; $ucs = 1.56$; $sc = 0$; $ls = 0$;
$slant = .25$; $sqrttwo =$ sqrt 2; $fixwidth = 0$;
$halfd = 0$; $lowast = 0$; $ligs = 0$; $mi = 1$.

input cmbase; call *fontbegin*;
input italic;
end



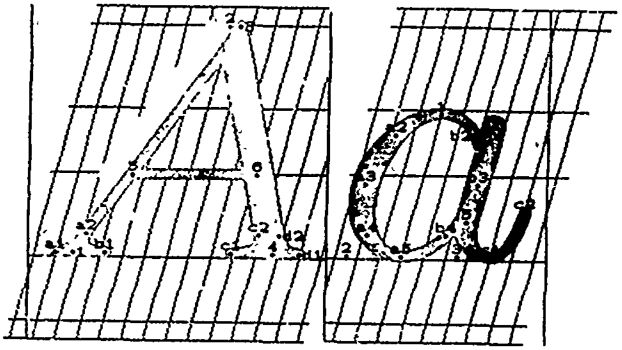
	0	1	2	3	4	5	6	7
'000	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ
'010	Φ	Ψ	Ω	α	β	γ	δ	ε
'020	ζ	η	θ	ι	κ	λ	μ	ν
'030	ξ	π	ρ	σ	τ	υ	φ	χ
'040	[illegible]	[illegible]	[illegible]	ε	ρ	ϑ	ϑ	[illegible]
'050	(	)	•	+	,	-	. .	/
'060	0	1	2	3	4	5	6	7
'070	8	9	:	;	<	=	>	?
'100	∂	A	B	C	D	E	F	G
'110	H	I	J	K	L	M	N	O
'120	P	Q	R	S	T	U	V	W
'130	X	Y	Z	/		/		
'140	'	a	b	c	d	e	f	g
'150	h	i	j	k	l	m	n	o
'160	p	q	r	s	t	u	v	w
'170	x	y	z	ψ	ω	φ	θ	ϖ

Mathematics books and journals do not look as beautiful as they used to. It is not that their mathematical content is unsatisfactory, rather that the old and well developed traditions of typesetting have become too expensive. Fortunately, it now appears that mathematics itself can be used to solve this problem, in spite of the fact that the first edition of ϕeop's χuvres is naïve about the efficient preparation of flawless soufflés. This is a sample of the font when the resolution is 200 dots per inch and 3.6 dots per "point".

The file cmi7.mf

"Computer Modern Math Italic 7 point";
$ph = \frac{175}{36}$; $px = \frac{112}{36}$; $pe = \frac{93}{36}$; $pd = \frac{49}{36}$;
$pb = \frac{14}{36}$; $po = \frac{3}{36}$; $ps = \frac{11}{36}$; $pa = .5(ph - pd)$;
$pw = \frac{8}{36}$; $pwi = \frac{17}{36}$; $pwii = \frac{20}{36}$; $pwiii = \frac{23}{36}$;
$pwiv = \frac{20}{36}$; $pwv = \frac{23}{36}$; $aspect = 1.0$;
$pu = \frac{18}{36}$; $lcs = .969$; $ucs = 1.44$; $sc = 0$; $ls = .25$;
$slant = .25$; $sqrttwo = \mathrm{sqrt}\,2$; $fixwidth = 0$;
$halfd = 0$; $lowast = 0$; $ligs = 0$; $mi = 1$.

input cmbase;   call *fontbegin*;
input italic;
end



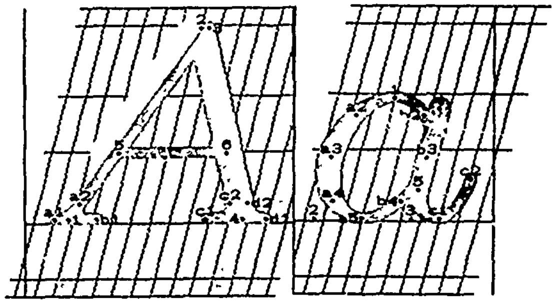
	0	1	2	3	4	5	6	7
'000	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ
'010	Φ	Ψ	Ω	α	β	γ	δ	ε
'020	ζ	η	θ	ι	κ	λ	μ	ν
'030	ξ	π	ρ	σ	τ	υ	φ	χ
'040	[illegible]	!	[illegible]	ℓ	[illegible]	ϑ	ϖ	'
'050	(	)	*	+	,	-	.	/
'060	0	1	2	3	4	5	6	7
'070	8	9	:	;	<	=	>	?
'100	∂	A	B	C	D	E	F	G
'110	H	I	J	K	L	M	N	O
'120	P	Q	R	S	T	U	V	W
'130	X	Y	Z	[		]		
'140	[illegible]	a	b	c	d	e	f	g
'150	h	i	j	k	l	m	n	o
'160	p	q	r	s	t	u	v	w
'170	x	y	z	ψ	ω	ϱ	ϑ	ϖ

Mathematics books and journals do not look as beautiful as they used to. It is not that their mathematical content is unsatisfactory, rather that the old and well developed traditions of typesetting have become too expensive. Fortunately, it now appears that mathematics itself can be used to solve this problem, in spite of the fact that the first edition of ϕoop's χuvres is naive about the efficient preparation of flawless soufflés. This is a sample of the font when the resolution is 200 dots per inch and 2.8 dots per "point".

The file `cmi6.mf`

"Computer Modern Math Italic 6 point";
$ph = \frac{150}{36}$; $px = \frac{90}{36}$; $pe = \frac{54}{36}$; $pd = \frac{42}{36}$;
$pb = \frac{12}{36}$; $po = \frac{2}{36}$; $ps = \frac{12}{36}$; $pa = .5(ph - pd)$;
$pw = \frac{8}{36}$; $pwi = \frac{19}{36}$; $pwii = \frac{19}{36}$; $pwiii = \frac{21}{36}$;
$pwiv = \frac{19}{36}$; $pwv = \frac{21}{36}$; $aspect = 1.0$;
$pu = \frac{14}{36}$; $lcs = .59$; $ucs = 1.43$; $sc = 0$; $ls = \frac{6}{14}$;
$slant = .25$; $sqrttwo = \text{sqrt}\,2$; $fixwidth = 0$;
$halfd = 0$; $lowast = 0$; $ligs = 0$; $mi = 1$.

input cmbase; call *fontbegin*;
input italic;
end



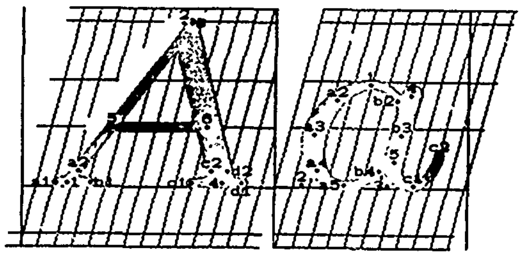
	0	1	2	3	4	5	6	7
'000	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ
'010	Φ	Ψ	Ω	α	β	γ	δ	ε
'020	ζ	η	θ	ι	κ	λ	μ	ν
'030	ξ	π	ρ	σ	τ	υ	φ	χ
'040	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
'050	(	)	[illegible]	+	,	-	.	/
'060	0	1	2	3	4	5	6	7
'070	8	9	:	;	<	=	>	?
'100	[illegible]	A	B	C	D	E	F	G
'110	H	I	J	K	L	M	N	O
'120	P	Q	R	S	T	U	V	W
'130	X	Y	Z	[		]		
'140	[illegible]	a	b	c	d	e	f	g
'150	h	i	j	k	l	m	n	o
'160	p	q	r	s	t	u	v	w
'170	x	y	z	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Mathematics books and journals do not look as beautiful as they used to. It is not that their mathematical content is unsatisfactory, rather that the old and well developed traditions of typesetting have become too expensive. Fortunately, it now appears that mathematics itself can be used to solve this problem, in spite of the fact that the first edition of [illegible]'s [illegible] is vague about the efficient preparation of [illegible]. This is a sample of the font when the resolution is 200 dots per inch and 2.8 dots per "point".

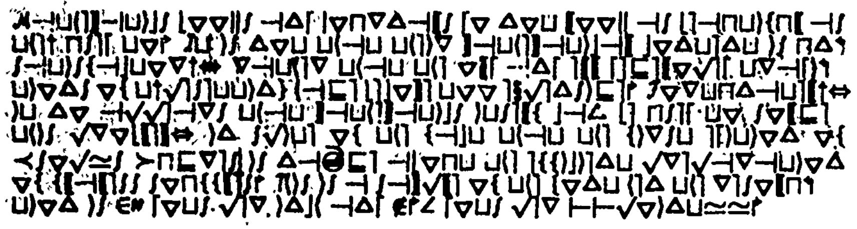
The file cmi5.mf

"Computer Modern Math Italic 5 point";
$ph = \frac{125}{36}$; $px = \frac{80}{36}$; $pe = \frac{45}{36}$; $pd = \frac{35}{36}$;
$pb = \frac{10}{36}$; $po = \frac{2}{36}$; $ps = \frac{10}{36}$; $pa = .5(ph - pd)$;
$pw = \frac{7}{36}$; $pwi = \frac{15}{36}$; $pwii = \frac{18}{36}$; $pwiii = \frac{19}{36}$;
$pwiv = \frac{18}{36}$; $pwv = \frac{19}{36}$; $aspect = 1.0$;
$pu = \frac{12.5}{36}$; $lcs = .84$; $ucs = 1.32$; $sc = 0$; $ls = 10/12.5$;
$slant = .25$; $sqrttwo = \mathrm{sqrt}\,2$; $fixwidth = 0$;
$halfd = 0$; $lowast = 0$; $lige = 0$; $mi = 1$.

input cmbase;   call *fontbegin*;
input italic;
end



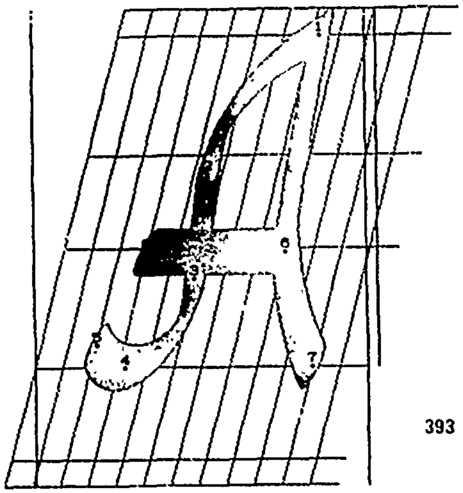
	0	1	2	3	4	5	6	7
'000	−	·	×	∗	\	∘	±	∓
'010	⊕	⊖	⊗	⊘	⊙	÷	†	•
'020	⊥	≡	⊆	⊇	≤	≥	⪯	⪰
'030	∼	≈	⊂	⊃	≠	≐	≺	≻
'040	←	→	↑	↓	↔	≪	≫	≃
'050	⇐	⇒	⇑	⇓	⇔	↰	↱	↦
'060	′	∞	∈	∉	●	‿	∠	
'070	∀	∃	¬	ℵ	ℜ	ℑ	⊤	/
'100	⁄	𝒜	ℬ	𝒞	𝒟	ℰ	ℱ	𝒢
'110	ℋ	ℐ	𝒥	𝒦	ℒ	ℳ	𝒩	𝒪
'120	𝒫	𝒬	ℛ	𝒮	𝒯	𝒰	𝒱	𝒲
'130	𝒳	𝒴	𝒵	∪	∩	⊎	∧	∨
'140	⊢	⊣	⌊	⌋	⌈	⌉	{	}
'150	⟨	⟩	|	‖	⟦	⟧	△	▽
'160	√	♯	∇	∫	⊔	⊓	⊑	
'170	§	†	‡	¶	●	©	£	$

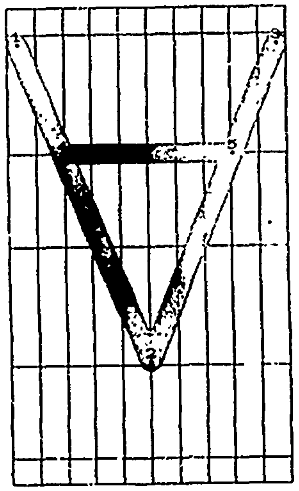


The file cmsy10.mf

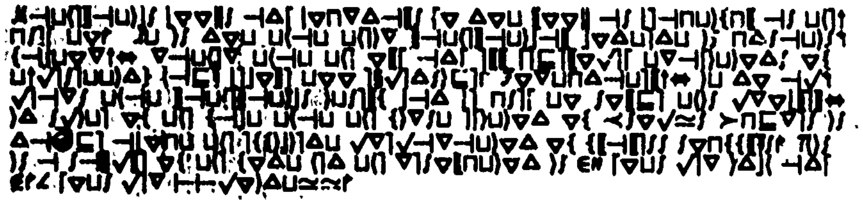
"Computer Modern Symbols 10 point";
$ph = \frac{250}{36};\quad px = \frac{160}{36};\quad pe = \frac{90}{36};\quad pd = \frac{70}{36};$
$pb = \frac{20}{36};\quad po = \frac{4}{36};\quad ps = \frac{20}{36},\quad pa = .5(ph - pd);$
$pw = \frac{9}{36};\quad pwi = \frac{27}{36};\quad pwii = \frac{32}{36};\quad pwiii = \frac{38}{36};$
$pwiv = \frac{32}{36};\quad pwv = \frac{38}{36};\quad aspect = 1.0;$
$pu = \frac{20}{36};\quad lcs = 1.075;\quad ucs = 1.7;\quad sc = 0;\quad ls = 0;$
$slant = .25;\quad sqrttwo = \mathrm{sqrt}\,2;\quad fixwidth = 0;$
$halfd = 0.$

```
input cmbase;   call fontbegin;
input symbol;
texinfo 0,                     % math spacing shoud be variable
     228/36,                   % numerator baseline in displays
     113/36,                   % numerator baseline in nondisplays, nonatops
     162/36,                   % numerator baseline in nondisplay atops
     244/36,                   % denominator baseline in displays
     108/36,                   % denominator baseline in nondisplays
     141/36,                   % superscript baseline in unmodified displays
     130.9/36,                 % superscript baseline in unmodified nondisplays
     104/36,                   % superscript baseline in modified styles
     54/36,                    % subscript baseline when superscript absent
     99/36,                    % subscript baseline when superscript present
     142/36,                   % baseline offset for superscripted large boxes
     18/36,                    % baseline offset for subscripted large boxes
     23.9,                     % size of \comb delimiters in displays
     10.1,                     % size of \comb delimiters in nondisplays
     pa;                       % axis height
end
```





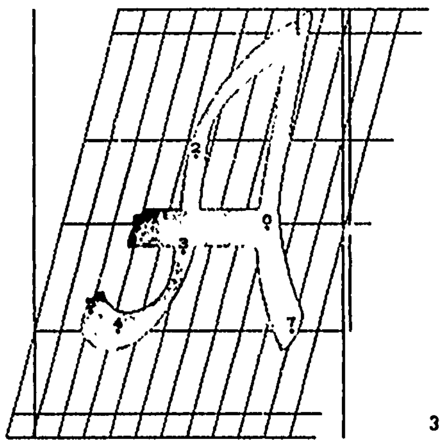
	0	1	2	3	4	5	6	7
'000	−	·	×	•	\	•	±	∓
'010	⊕	⊖	⊗	⊘	⊙	+	†	•
'020	⊥	≡	⊆	⊇	≤	≥	⪯	⪰
'030	∼	≈	⊂	⊃	≠	∗	≺	≻
'040	←	→	↑	↓	↔	≪	≫	≃
'050	⇐	⇒	⇑	⇓	⇔	↖	↗	↦
'060	′	∞	∈	∉	∅	-	∠	
'070	∀	∃	¬	ℵ	ℜ	ℑ	⊤	/
'100	/	𝒜	ℬ	𝒞	𝒟	ℰ	ℱ	𝒢
'110	ℋ	ℐ	𝒥	𝒦	ℒ	ℳ	𝒩	𝒪
'120	𝒫	𝒬	ℛ	𝒮	𝒯	𝒰	𝒱	𝒲
'130	𝒳	𝒴	𝒵	∪	∩	⊎	∧	∨
'140	⊢	⊣	⌊	⌋	⌈	⌉	{	}
'150	(	)	|	‖	[	]	△	▽
'160	√	#	∇	∫	⊔	⊓	⊑	
'170	§	†	‡	¶	●	●	£	$

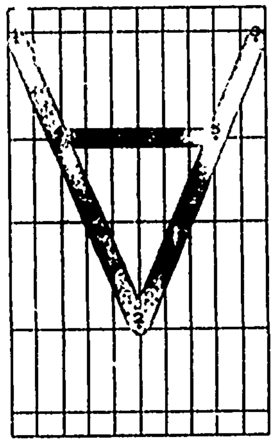


The file cmsy9.mf

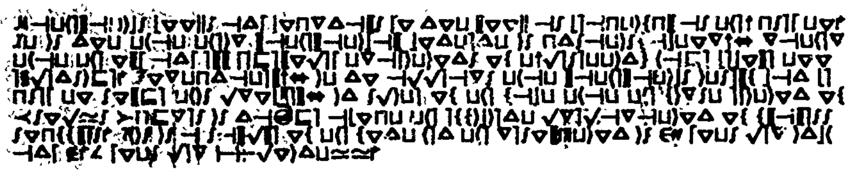
"Computer Modern Symbols 9 point";
$ph = \frac{225}{36}$; $px = \frac{144}{36}$; $pe = \frac{81}{36}$; $pd = \frac{93}{36}$;
$pb = \frac{18}{36}$; $po = \frac{4}{36}$; $ps = \frac{18}{36}$; $pa = .5(ph - pd)$;
$pw = \frac{9}{36}$; $pwi = \frac{25}{36}$; $pwii = \frac{29}{36}$; $pwiii = \frac{33}{36}$;
$pwiv = \frac{29}{36}$; $pwv = \frac{33}{36}$; $aspect = 1.0$;
$pu = \frac{18.5}{36}$; $lcs = 1.05$; $ucs = 1.65$; $sc = 0$; $ls = 0$;
$slant = .25$; $sqrttwo = \text{sqrt}\,2$; $fixwidth = 0$;
$halfd = 0$.

```
input cmbase;   call fontbegin;
input symbol;
texinfo 0,                      % math spacing should be variable
      221/36,                   % numerator baseline in displays
      104/36,                   % numerator baseline in nondisplays, nonatops
      146/36,                   % numerator baseline in nondisplay atops
      237/36,                   % denominator baseline in displays
      92/36,                    % denominator baseline in nondisplays
      129/36,                   % superscript baseline in unmodified displays
      110.9/36,                 % superscript baseline in unmodified nondisplays
      93/36,                    % superscript baseline in modified styles
      36/36,                    % subscript baseline when superscript absent
      81/36,                    % subscript baseline when superscript present
      126/36,                   % baseline offset for superscripted large boxes
      18/36,                    % baseline offset for subscripted large boxes
      23.9,                     % size of \comb delimiters in displays
      9.1,                      % size of \comb delimiters in nondisplays
      pa;                       % axis height
end
```





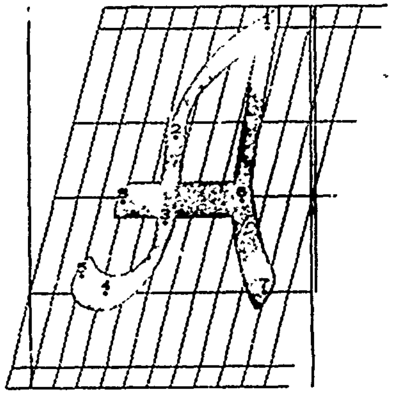
	0	1	2	3	4	5	6	7
'000	−	·	×	•	\	•	±	∓
'010	⊕	⊖	⊗	⊘	⊙	+	⊤	•
'020	⊥	≡	⊆	⊇	≤	≥	⪯	⪰
'030	∼	≈	⊂	⊃	≰	≐	≺	≻
'040	←	→	↑	↓	↔	≪	≫	≃
'050	⇐	⇒	⇑	⇓	⇔	↖	↗	↦
'060	′	∞	∈	∉	▮	-	∠	
'070	∀	∃	¬	✱	✱	9	⊤	/
'100	/	𝒜	ℬ	𝒞	𝒟	ℰ	ℱ	𝒢
'110	ℋ	ℐ	𝒥	𝒦	ℒ	ℳ	𝒩	𝒪
'120	𝒫	𝒬	ℛ	𝒮	𝒯	𝒰	𝒱	𝒲
'130	𝒳	𝒴	𝒵	∪	∩	⊎	∧	∨
'140	⊢	⊣	⌊	⌋	⌈	⌉	{	}
'150	⟨	⟩	|	‖	[	]	△	▽
'160	√	✱	∇	∫	⊔	⊓	⊑	
'170	§	†	‡	¶	●	●	£	$

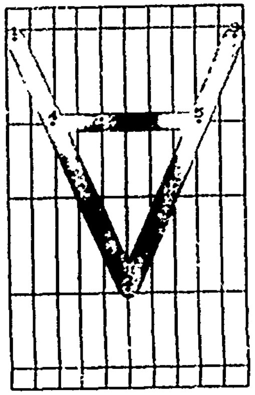


The file cmsy8.mf

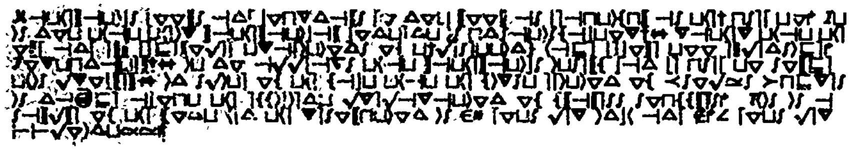
"Computer Modern Symbols 8 point";
$ph = \frac{200}{36}$; $px = \frac{128}{36}$; $pe = \frac{72}{36}$; $pd = \frac{38}{36}$;
$pb = \frac{10}{36}$; $po = \frac{3}{36}$; $ps = \frac{18}{36}$; $pa = .5(ph - pd)$;
$pw = \frac{9}{36}$; $pwi = \frac{23}{36}$; $pwii = \frac{27}{36}$; $pwiii = \frac{30}{36}$;
$pwiv = \frac{27}{36}$; $pwv = \frac{30}{36}$; $aspect = 1.0$,
$pu = \frac{17}{36}$; $lcs = 1.03$; $ucs = 1.56$; $sc = 0$; $ls = 0$;
$slant = .25$; $sqrttwo = \mathrm{sqrt}\,2$; $fixwidth = 0$;
$halfd = 0$.

```
input cmbase;   call fontbegin;
input symbol;
texinfo 0,                                      % math spacing should be variable
     189/36,                                      % numerator baseline in displays
     95/36,                 % numerator baseline in nondisplays, nonatops
     137/36,                     % numerator baseline in nondisplay atops
     203/36,                            % denominator baseline in displays
     76/36,                          % denominator baseline in nondisplays
     113/36,                  % superscript baseline in unmodified displays
     104/36,               % superscript baseline in unmodified nondisplays
     82/36,                      % superscript baseline in modified styles
     36/36,                  % subscript baseline when superscript absent
     72/36,                  % subscript baseline when superscript present
     110/36,               % baseline offset for superscripted large boxes
     18/36,                  % baseline offset for subscripted large boxes
     11.S,                           % size of \comb delimiters in displays
     9.1,                         % size of \comb delimiters in nondisplays
     pa;                                                      % axis height
end
```



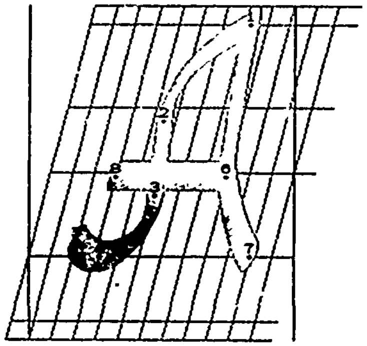


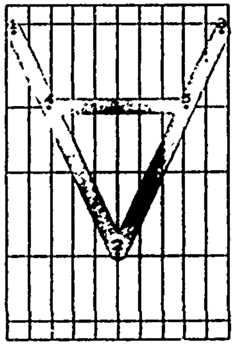
	0	1	2	3	4	5	6	7
′000	−	·	×	∗	\	∘	±	∓
′010	⊕	⊖	⊗	⊘	⊙	∔	↑	•
′020	⊥	≡	⊆	⊇	≤	≥	⪯	⪰
′030	∼	≈	⊂	⊃	≠	≐	≺	≻
′040	←	→	↑	↓	↔	≪	≫	≃
′050	⇐	⇒	⇑	⇓	⇔	↖	↗	↦
′060	′	∞	∈	∉	▮	-	∠	
′070	∀	∃	¬	✖	■	●	⊤	/
′100	/	𝒜	ℬ	𝒞	𝒟	ℰ	ℱ	𝒢
′110	ℋ	ℐ	𝒥	𝒦	ℒ	ℳ	𝒩	𝒪
′120	𝒫	𝒬	ℛ	𝒮	𝒯	𝒰	𝒱	𝒲
′130	𝒳	𝒴	𝒵	∪	∩	⊎	∧	∨
′140	⊢	⊣	⌊	⌋	⌈	⌉	{	}
′150	⟨	⟩	|	‖	⟦	⟧	△	▽
′160	√	#	▼	∫	⊔	⊓	⊑	
′170	§	†	‡	¶	●	©	£	$



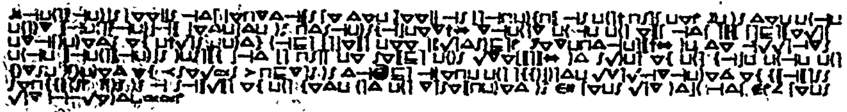
The file cmsy7.mf

```
"Computer Modern Symbols 7 point";
ph = 175/36;   px = 112/36;   pe = 63/36;   pd = 49/36;
pb = 14/36;   po = 3/36;   ps = 14/36;   pa = .5(ph − pd);
pw = 8/36;   pwi = 21/36;   pwii = 24/36;   pwiii = 28/36;
pwiv = 24/36;   pwv = 28/36;   aspect = 1.0;
pu = 10/36;   lcs = .97;   ucs = 1.44;   sc = 0;   ls = 0;
slant = .25;   sqrttwo = sqrt 2;   fixwidth = 0;
halfd = 0.

input cmbase;   call fontbegin;
input symbol;
texinfo 0,                      % math spacing should be variable
    169/36,                     % numerator baseline in displays
    86/36,                      % numerator baseline in nondisplays, nonatops
    121/36,                     % numerator baseline in nondisplay atops
    182/36,                     % denominator baseline in displays
    85/36,                      % denominator baseline in nondisplays
    93/36,                      % superscript baseline in unmodified dirplays
    84/36,                      % superscript baseline in unmodified nondisplays
    72/36,                      % superscript baseline in modified styles
    36/36,                      % subscript baseline when superscript absent
    72/36,                      % subscript baseline when superscript present
    94/36,                      % baseline offset for superscripted large boxes
    18/36,                      % baseline offset for subscripted large boxes
    11.9,                       % size of \comb delimiters in displays
    8.1,                        % size of \comb delimiters in nondisplays
    pa;                         % axis height
end
```



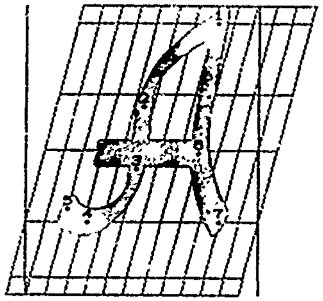


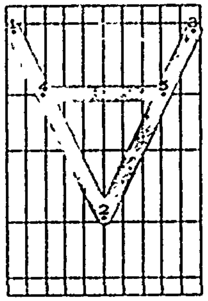
	0	1	2	3	4	5	6	7
'000	−	·	×	∗	\	∘	±	∓
'010	⊕	⊖	⊗	⊘	⊙	+	†	•
'020	⊥	≡	⊆	⊇	≤	≥	⪯	⪰
'030	∼	≈	⊂	⊃	≠	≃	≺	≻
'040	←	→	↑	↓	↔	≪	≫	∝
'050	⇐	⇒	⇑	⇓	⇔	↖	↗	⇢
'060	′	∞	∈	∉	∅	-	∠	
'070	∀	∃	¬	♭	♮	♯	⊤	∫
'100	/	𝒜	ℬ	𝒞	𝒟	ℰ	ℱ	𝒢
'110	ℋ	ℐ	𝒥	𝒦	ℒ	ℳ	𝒩	𝒪
'120	𝒫	𝒬	ℛ	𝒮	𝒯	𝒰	𝒱	𝒲
'130	𝒳	𝒴	𝒵	∪	∩	⊎	∧	∨
'140	⊢	⊣	⌊	⌋	⌈	⌉	{	}
'150	⟨	⟩	|	‖	[	]	△	▽
'160	√	∐	∇	∫	⊔	⊓	⊑	
'170	§	†	‡	¶	♣	♢	♡	♠



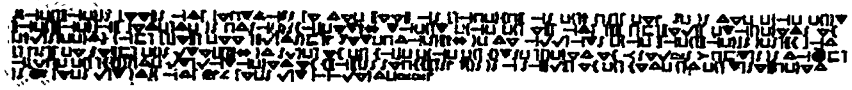
The file cmsy6.mf

```
"Computer Modern Symbols 6 point";
ph = 150/36;   px = 99/36;   pe = 51/36;   pd = 12/36;
pb = 12/36;   po = 2/36;   ps = 12/36;   pa = .5(ph − pd);
pw = 8/36;   pwi = 19/36;   pwii = 22/36;   pwiii = 23/36;
pwiv = 22/36;   pwv = 23/36;   aspect = 1.0;
pu = 14/36;   lcs = .89;   ucs = 1.43;   sc = 0;   ls = 0;
slant = .25;   sqrttwo = sqrt 2;   fixwidth = 0;
halfd = 0.

input cmbase;   call fontbegin;
input symbol;
texinfo 0,                                   % math spacing should be variable
     150/36,                                 % numerator baseline in displays
     77/36,                % numerator baseline in nondisplays, nonatops
     112/36,                     % numerator baseline in nondisplay atops
     162/36,                              % denominator baseline in displays
     94/36,                            % denominator baseline in nondisplays
     81/36,                  % superscript baseline in unmodified displays
     72/36,               % superscript baseline in unmodified nondisplays
     62/36,                     % superscript baseline in modified styles
     36/36,                  % subscript baseline when superscript absent
     72/36,                  % subscript baseline when superscript present
     78/36,              % baseline offset for superscripted large boxes
     17/36,                % baseline offset for subscripted large boxes
     11.9,                         % size of \comb delimiters in displays
     8.1,                       % size of \comb delimiters in nondisplays
     pa;                                                   % axis height
end
```





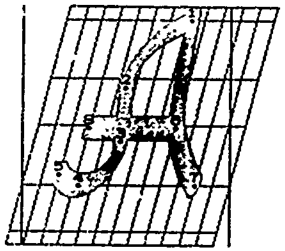
	0	1	2	3	4	5	6	7
'000	−	·	×	•	\	•	±	∓
'010	●	⊖	●	⊘	⊙	+	†	•
'020	⊥	≡	⊆	⊇	≤	≥	⪯	⪰
'030	∼	≈	⊂	⊃	≠	≐	≺	≻
'040	←	→	↑	↓	↔	≪	≫	≃
'050	⇐	⇒	⇑	⇓	⇔	⌝	⌜	↦
'060	′	∞	∈	∉	●	-	∠	
'070	∀	∃	¬	[illegible]	ℜ	ℑ	⊤	/
'100	/	𝒜	ℬ	𝒞	𝒟	ℰ	ℱ	𝒢
'110	ℋ	ℐ	𝒥	𝒦	ℒ	ℳ	𝒩	𝒪
'120	𝒫	𝒬	ℛ	𝒮	𝒯	𝒰	𝒱	𝒲
'130	𝒳	𝒴	𝒵	∪	∩	⊎	∧	∨
'140	⊢	⊣	⌊	⌋	⌈	⌉	{	}
'150	⟨	⟩	|	‖	⟦	⟧	△	▽
'160	✓	♯	▼	∫	⊔	⊓	⊑	
'170	§	†	‡	¶	●	●	[illegible]	[illegible]

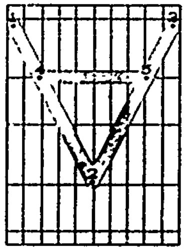


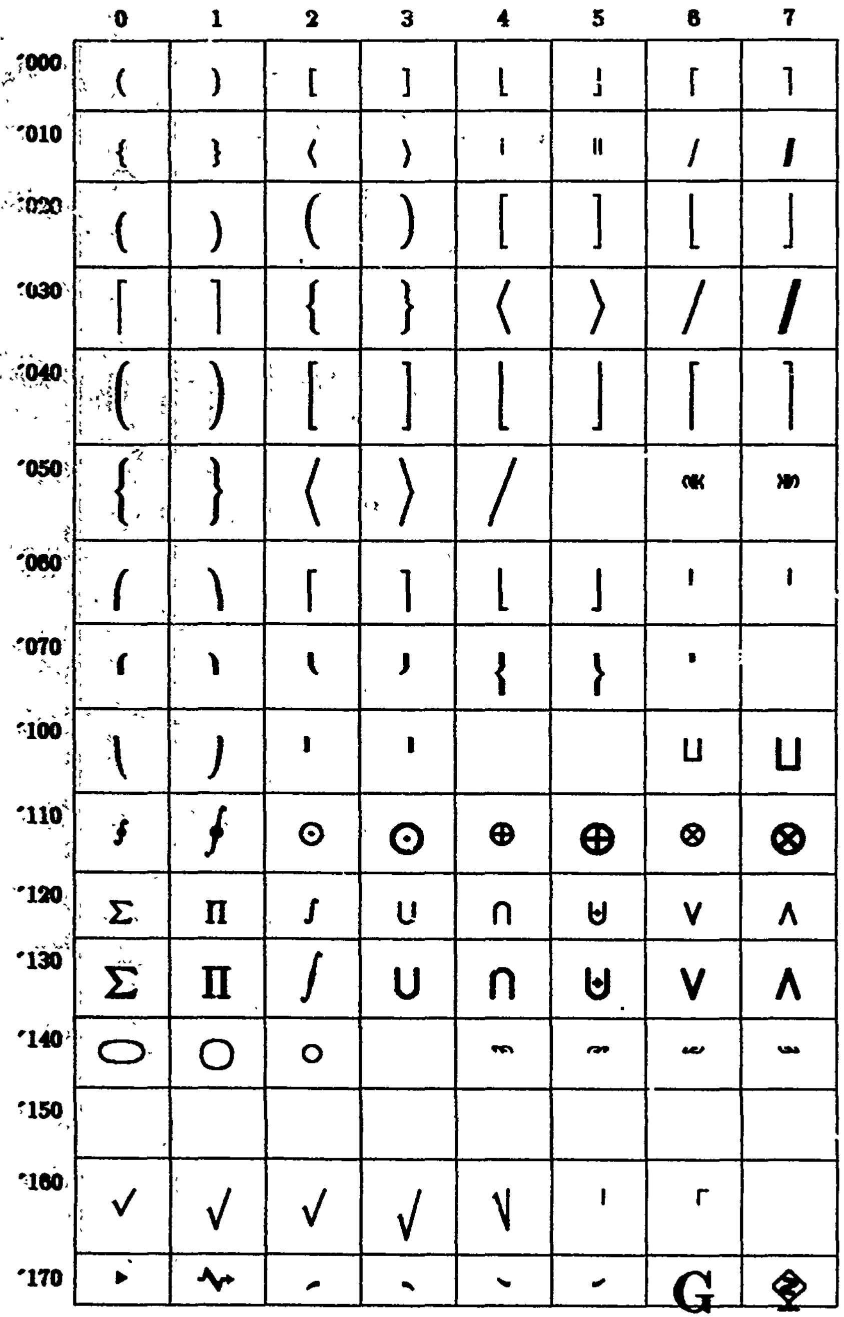
The file cmsy5.mf

"Computer Modern Symbols 5 point";
$ph = \frac{125}{36}$; $px = \frac{80}{36}$; $pe = \frac{45}{36}$; $pd = \frac{35}{36}$;
$pb = \frac{10}{36}$; $po = \frac{2}{36}$; $ps = \frac{10}{36}$; $pa = .5(ph - pd)$;
$pw = \frac{7}{36}$; $pwi = \frac{17}{36}$; $pwii = \frac{12}{36}$; $pwiii = \frac{20}{36}$;
$pwiv = \frac{12}{36}$; $pwv = \frac{20}{36}$; $aspect = 1.0$;
$pu = \frac{12.5}{36}$; $lcs = .84$; $ucs = 1.32$; $sc = 0$; $ls = 0$;
$slant = .25$; $sqrttwo = \mathrm{sqrt}\,2$; $fixwidth = 0$;
$halfd = 0$.

```
input cmbase;   call fontbegin;
input symbol;
texinfo 0,                    % math spacing should be variable
     130/36,                  % numerator baseline in displays
     68/36,                   % numerator baseline in nondisplays, nonatops
     103/36,                  % numerator baseline in nondisplay atops
     142/36,                  % denominator baseline in displays
     103/36,                  % denominator baseline in nondisplays
     69/36,                   % superscript baseline in unmodified displays
     60/36,                   % superscript baseline in unmodified nondisplays
     53/36,                   % superscript baseline in modified styles
     36/36,                   % subscript baseline when superscript absent
     72/36,                   % subscript baseline when superscript present
     62/36,                   % baseline offset for superscripted large boxes
     16/36,                   % baseline offset for subscripted large boxes
     9.9,                     % size of \comb delimiters in displays
     7.1,                     % size of \comb delimiters in nondisplays
     pa;                      % axis height
end
```






0
1
2
3
4
5
6
7
'000
'010
'020
'030
'040
'050
'060
'070
'100
'110
'120
'130
'140
'150
'160
'170

The file cmathx.mf

```
"Computer Modern Math Extension Font";
ph = 250/36;   px = 160/36;   pe = 90/36;   pd = 70/36;
pb = 20/36;   po = 4/36;   ps = 20/36;   pa = .5(ph − pd);
pw = 9/36;   pwi = 27/36;   pwii = 32/36;   pwiii = 38/36;
pwiv = 32/36;   pwv = 38/36;   aspect = 1.0;
pu = 20/36;   lcs = 1.075;   ucs = 1.7;   sc = 0;   ls = 0;
slant = 0;   sqrttwo = sqrt 2;   fixwidth = 0;
halfd = 0.

input cmbase;   call fontbegin;
input mathex;
texinfo 40/36,                 % minimum glue space above large displayed operator
      60/36,                   % minimum glue space below large displayed operator
         108/36,                   % minimum distance to baseline of upper limit
         252/36,                   % minimum distance to baseline of lower limit
         108/36.              % extra padding above and below displayed limits

end
```

INDEX

For each character code number, this index lists all pages that define a character having that code. An entry like "romext" means that the code is not defined for the roman font in this report, but it could be defined as a nonstandard character in the romext extension font.